SCIENCE

FRIDAY, OCTOBER 8, 1909

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THE REHABILITATION OF THE AMERICAN COLLEGE, AND THE PLACE OF CHEMISTRY IN IT[1]

THERE are two subjects which at present occupy the focus of public interest in the United States; namely, the American tariff and the American college. One difference between the situations in the two cases seems to be that whereas a few people are strongly in favor of the tariff, nobody has a good word to say for the college. Perhaps a reservation should be made in regard to the latter; one senator, apparently, thinks that the negative quality of inefficiency is better than none at all. His words are: "I love my *alma mater* for all she has enabled me to be and to do, in spite of herself." He finds virtue in her very laxness.

Can we as chemists confidently feel that Flexner and Birdseye in their voluminous writings, and the myriad commencement orators in their more or less seasonable outpourings, have all spoken with a definite mental reservation? Can it be that all the unpleasant things that they have said were intended to apply to the whole structure of the American college, with the sole exception of its department of chemistry? I fear not. If then the American college is an Augean stable, shall we wait in the hope that some Hercules will come and clean it all in twenty-four hours, or shall we take off our coats and tackle the problem of our own stall?

[1] An address before the Section of Education of the American Chemical Society, at the Detroit meeting, July, 1909.

THE OLD COLLEGE AND THE NEW

The early American colleges suffered from no such torrent of criticism. For a time, indeed, some of them were blamed because they raised money for religious instruction by means of lotteries. But against the seriousness of their scholarship and the strictness of their discipline no voice was raised. The Latin, the New Testament Greek, the Semitic languages and the essay writings, sermon making, public speaking and debating, which practically filled the curriculum, were precisely the subjects required for their purpose. They were professional schools of divinity, and seventy-five per cent. of the graduates eventually became clergymen. Even to those who became lawyers and physicians, most of these subjects did not come amiss. The law was written in Latin and briefs and writs were prepared in Latin. Even the works on medicine were printed in the same tongue. The general appropriateness of the requirements was so evident that the student could not help being held fast, and could not help being carried along by the purposeful spirit of the place. Other learned institutions did not exist, and after a little more study, and some practical experience, the graduate was ready for his duties as preacher, lawyer or doctor.

Many changes, of which two may be mentioned, have altered the whole situation. In the first place, with the development of our knowledge along medical lines, and the greater demands made upon the lawyer and the clergyman, the college can no longer affect to be in any sense a professional school. It furnishes as much training in the same subjects as ever, in fact it furnishes more, but all that it does is so much smaller a fraction of the total professional course, that the purposeful state of mind of the professional student has entirely left its walls.

In the second place, the influx of another body of students will soon have reduced to a minority the proportion of its graduates destined to enter one of the learned professions. Only three or four per cent. of the graduates of Yale (formerly the official divinity school of the neighboring colonies) now enter the church, while forty per cent. become business men. Yet the American college has never attempted to be a professional school of business. Thus, by its failure to retain its old character as a professional school, the college has lost one of the main sources of its hold upon the interests of the student body. The colleges could not follow the development of all the professions, so they made no attempt to follow any. With the help of the elective system, they became bargain counters, or rather, since there was not always even a salesman specially deputed to give advice, the more advanced ones became mere automatic cafés.

Simultaneously with all this, the college has given up its attempt to form the character of its students by the enforcement of strict regulations. The student is no longer guarded against all temptation to form bad habits. He is no longer furnished with exercises and customs calculated to produce good habits.

Thus the college has relinquished its once effective plans for training professional men and for turning out men of character. The structures which performed these functions have fallen into disuse. The college as an educational institution is biologically a mere rudiment of a formerly vital and useful organ in the body politic. As one of its critics has said, "It is a sort of educational vermiform appendix."

Given an appendix, appendicitis is sooner or later bound to appear. We are now at

the bedside of the patient and, judging from the statements of numerous experts, the college appears to be the seat of a most violent inflammation. What is to be done with the victim of this appalling disease?

Analogy suggests that the offending organ might be cut off. But the American college, not being attached to anything, can not be removed. We might resolve to abolish the American college, but the American colleges would remain. And perhaps, after all, there is a place for the American college. The professional schools are rapidly adding a certain amount of college work to their admission requirements. It is true that some high schools have added two years to their curriculum, but the gap between the high school and the professional school is widening faster than it can be filled by the development of the secondary institutions. Here is still ample room for the American college.

THE COLLEGE A PLACE FOR CULTURE

We must regard as purely futile the suggestion that the college should be turned into a place for culture, if by this term is to be understood something distinct from scholarship. Flexner[2] quotes with approval the statement of Professor Mann, in which, after indicating the rigid nature of the work of technical students, he says:

> For the non-technical or general student, college laboratory work is neither essential nor desirable; the emphasis in this case should be laid upon the services of science in developing and maintaining intellectual, social and economic life.

An education composed entirely of this sort of work will not appeal strongly to chemists. Are not deep knowledge and rigid training in science required before the services of science in developing intellectual, social and economic life, can be properly appreciated? Is the giving of a culture course of this description not an attempt to produce *fruit* without the assistance of organs of nutrition and growth? Is a course which sets out with the definite aim of conferring culture, and nothing else, ever anything but a "soft snap"? Stimulating it may be, if given by an exceptional personality, but a good deal like the lemon phosphate and the ice cream soda, temporary in its effects. It pleases our palate for the moment and a week later is not even so much as a pleasing memory. I wonder if culture is not rather to be sought as a *by-product*—a by-product of cultured parentage and sound education—rather than as an end in itself?

THE COLLEGE FOR TEACHING PROBLEM-SOLVING

What important ends of subsequent life can the college course appropriately serve? Is not the chief exercise in every profession, and in all lines of business, that of solving problems?[3] Shall we not then so devise our methods of instruction that the student may gain experience in the exercise of this most important function. Shall we not teach him to suspend his judgment, instead of acting upon the first idea that comes into his head? Shall we not train him to search for facts, and to realize when essential facts are still lacking? Shall we not exercise him in correct reasoning from the facts when they have been secured? Shall we not, finally, show him the necessity for testing his conclusions by careful comparison with the facts and show him how to do this? This is no light program. Certainly no subject has gained a right to admission to the college course until it has demonstrated its capacity for being taught in this fashion.

[2] SCIENCE, N. S., XXIX., p. 366.

[3] See Professor A. A. Noyes's recent address, "A Talk on Teaching."

THE COLLEGE AS A PRE-PROFESSIONAL SCHOOL

So much for the general aim of the instruction. As regards the curriculum, would it not be well to hark back to the plan of the old college, with suitable modifications? The college can no longer furnish complete professional training, but it can do pre-professional work. It can do work of professional quality, so far as it goes. Let us exclude from the college rigidity all those whose aims are so indefinite that they are not willing to prepare for some profession. And I include banking, insurance and other lines of business amongst the professions, for, in spite of isolated opinions to the contrary, the college *can* furnish training in the sciences fundamental to business. Let the work be scholarly, exact and thorough. Let the chemistry and physics be a suitable foundation for further work in the same subjects, or for application in physiology and other more distinctly professional studies. Let the political economy prepare for more strictly professional courses in finance and transportation. If every student is engaged in one of these pre-professional curricula, shall we not be able in a large measure to restore the purposefulness of the old colleges? True, we can never reintroduce the regulations and restrictions which guided the life and moulded the character of the early undergraduate. But, if we require every student in college to select some one curriculum, and exact of him scholarly work in every study, shall we not so occupy his attention, that waste of time will be reduced to a minimum, and social occupations will be relegated to the subordinate position which alone they are entitled to occupy?

To avoid possible misunderstanding, let me add that by pre-professional curricula I do not mean narrowly specialistic curricula. With six or eight years available for the total pre-professional and professional training, there should be ample room for breadth as well as for intensity. What I mean is that the present more or less complete waste of the first part of the total course, which is so liable at present to occur, should be rendered impossible.

TWO CHANGES IN THE PRESENT SITUATION REQUIRED

If the American college is to be rehabilitated along these lines, namely, those of teaching problem-solving and giving work of professional standard, or along any similar lines, two important improvements in the present situation are required. To give in all subjects the kind of instruction indicated will require *skilful teachers*, and it is generally admitted that the teaching of undergraduates is at present less satisfactory than is that of the pupils in the grades and high school on the one hand, or of the students in the graduate on the other. The second need is that of *more efficient methods of teaching*, particularly in non-linguistic subjects.

TRAINING IN THE ART OF TEACHING NEEDED

The various causes of poor instruction in our college classes have been discussed at length by Flexner and Birdseye. I wish to speak of only one out of the whole number. When we desire the services of a physician we seek a man who has been trained in the practise of medicine. And when we employ a lawyer we entrust our business to one who has had training in the practise of law, and not to one who has a merely theoretical knowledge of the subject. Yet when we set out to find a college teacher, we enquire for a doctor of philosophy. The doctor of philosophy is a person who has devoted several years mainly to the study of one subject and often of a small corner of one subject. He is a per-

son who has had his attention for a time directed, with the utmost insistence, exclusively to the making of some addition to human knowledge. He may be an investigator, but he is not necessarily anything else. Training in the art of teaching is not even a minor requirement for the degree. We are constantly told that teachers are born, not made. So, however, are the most successful lawyers and doctors. This "nascent" theory of teaching will not bear a moment's scrutiny. What natural mechanism exists that shall direct the born teachers into teaching, and shall prevent the born policeman and born stock speculators from drifting into the same line of work? Then again, is the born teacher necessarily able to teach without training? The discoverer of an important surgical operation was probably a born surgeon, yet, unless the story is entirely apocryphal, he destroyed a whole hatful of eyes before he found out how to perform the operation successfully. Should we permit all other surgeons, including those of less native ability, to learn the art in the same way? Since the art can be, and is, taught in a more economical fashion, should we not regard the continual repetition of the original process as an unbearable atrocity? Shall we then allow even the born teachers, not to speak of those who are not of this select group, to mutilate the minds of our youth while learning their business?

No one has yet analyzed successfully the attributes of the investigator, on the one hand, and the attributes of the teacher on the other, and placed them side by side, in such a way that the extent to which they are congruent can be determined. But, that the *natural qualities* of the investigator should include all natural qualities of the teacher, and that other qualities which the investigation *acquires by training in research* should include the whole art of teaching, can not for a moment be believed. Perhaps an analogy may serve to bring out the distinction. We might train a man in the theory of music, and drill him in musical composition, so as finally, with the assistance of his natural ability, to develop a successful composer. Yet, if the requirements for the doctor of philosophy in music did not include anything more, we should be extremely foolish to infer that the graduate would be able to perform upon some musical instrument. He would be in the precise position of that classical person who did not know whether he could play the violin or not, because he never had tried. His position would be only a shade less absurd than that of the individual (commonly known as the college president) who, knowing the candidate had never been trained to play, nevertheless selected him to fill a position in the college faculty orchestra.

Of course I am aware that the president searches diligently for *teaching experience* amongst the qualifications of the candidates, and very often succeeds in detecting distinct traces of it. But teaching experience is one thing, and skill in teaching is another. The self taught analyst is a lottery, with the chances much against the gambler. He may have succeeded in teaching himself more bad habits than good ones.

It is hardly necessary for me to say that we should welcome the investigator and, other things being equal, prefer him in making a college appointment. In the college teacher, a keen interest in research and the ability to do it are indispensable. It is for some rational method of adding to the research ability, a certain amount of instruction in the art of teaching that I am pleading. Surely some method can be devised by which the prospective college teacher may get over the cruder blunders and mis-

takes of his first years of teaching, in circumstances in which less harm will be done to the student—and perhaps to the man's own reputation. If he has already taught, it should be possible to cure him of some of the worst habits he may have formed. One of our problems seems to me, therefore, to be the improving of the teaching in college classes by some system of training college teachers.

IMPROVED METHODS OF TEACHING NEEDED

If we are to give work in college up to the professional standard and in such a way that training to solve the problems of after life is to be given, we must have, not only skilful teachers, but improved methods of teaching.

The method of teaching languages, partly because of the nature of the subject, and partly as a result of long experience, has been brought to a high degree of perfection. The grammar furnishes the laws and general principles, together with all the known exceptions. The dictionary supplies the isolated facts in such a way that they can be most readily found. The text provides the subject of study in constant and definite form. The method of studying a language is extremely simple and is easily worked into the habit of thought of the pupil. He learns from experience to suspend his judgment in regard to the meaning of the author until he is in possession of the facts. He knows exactly where to look for the facts and what facts to look for. He learns to reason correctly, and the nature of the subject is such that he almost always knows when he has reached the correct conclusion. In other words, every conclusion is tested, and every element in problem-solving by the scientific method is covered. Mistakes, when he makes them, are sooner or later detected and rectified. The method is simple, yet of unquestionable efficiency.

A method so simple and certain has not yet been devised for history, literature, political economy or chemistry. Perhaps the successful study of these subjects can never be made so easy as in the case of languages. Yet it should, at least, be possible to detect the fundamental characteristics which make the study of language successful and adapt them to the teaching of other subjects.

THE LECTURE METHOD

Can it be said that any such successful method is used in chemistry? Is there, indeed, a general method of any description in use? Most commonly a course of lectures occupies a prominent place in the scheme of instruction, and an even more prominent place in the estimation of the student. The lecture method has its advantages. The facts can be presented more graphically than by any book. The relations of the facts can be explained with greater lucidity and in a more impressive manner. Illustrations can be multiplied, as they could hardly be multiplied in a book. Experimental illustrations, which are impossible in print, can be given. Yet who would feel that a lecture on twenty-five French words, no matter how brilliant, followed by other lectures of the same kind, with occasionally a lucid and interesting exposition of the meaning and application of some rule, would confer an ability to read, construe or speak French? After all, it is the *student* who has to *acquire* the French. By vigorous and persistent exercise, *the student* has to possess himself of it completely. One might almost as well attempt to make a change in the plumbing of one's house by talking to it, or to drive a golf ball by the use of language—alone, as to teach French by lecturing.

It too frequently happens, although it is not a necessary part of the lecture system, that the lecture is given by one who has no

contact with the laboratory work and perhaps pays no particular attention to what is being done in the laboratory. On the other hand, the laboratory work or the discussions may be conducted by one who is not in touch with the other two parts of the instruction. That confusion and waste of effort in such circumstances should arise is not to be wondered at.

LECTURE VERSUS DISCUSSION PREPARED FOR IN ADVANCE

As I have suggested before, the successful features of language teaching might be imitated where they are applicable. For example, in Latin, we teach not merely the language but, just as continuously and unremittingly, *we teach the method of studying the language.* I find that more than half of the students in a college class have not the faintest idea how to set about studying chemistry. They spend quantities of time, yet, for lack of a method, obtain very slight results. Should we not, for example, explain to them how to notice the significance of each word in a law, and to expand the succinct terms in which it is stated? Should we not insist on their connecting each law with a set of illustrations; enjoin them to apply each illustration closely to the law, word by word; and finally advise them to close the book and see whether they can recall the facts that led up to the law, reproduce the full meaning of the terms in which it is stated, and make the application to the illustrations. Do we not simply *assume* that they will *invent* a method of study for themselves? It was years before I myself realized that I had been making this assumption, and how woefully wide of the truth it was.

It is a platitude to say that no method of teaching which disregards fundamental properties of the human mind can possibly be successful. Yet I must confess that I have used for years precisely such methods without realizing the fact. For example, the lecture places the student in a *passive and receptive attitude.* Yet it is not the reception, but the reproduction of an idea that fixes it in our memory. The *hearing* of a story makes no permanent impression. It is only after we have retold the story that it suddenly leaps into a permanent position in our repertoire. The first hearing of an idea produces but a faint track in the brain. It is the putting together of this idea, in its original setting, and also along with new ideas, that converts the first faint track into a traveled road. Is it not one of the strong points of language study, that the student must put together, in an endless variety of forms, the limited number of ideas he is trying to master, and must do this by his own efforts?

Again, *repetition,* explicit and persistent, is absolutely essential to fair acquisition. The lack of this in science teaching has recently been emphasized by President Remsen. Yet much repetition in a lecture is out of the question. It becomes tedious and boresome. It is like having the same person introduced to us formally five or six times over. We are conscious of boredom the second time, irritation the third time, rage the fourth time, and thereafter settled hatred of introducer and introduced alike whenever we hear that person's name. Yet, if we had been furnished with an opportunity spontaneously to recognize the person the second time, we should have been pleased to meet him on that occasion, we should have greeted him as an acquaintance on the third occasion, and have felt the impulse of close friendship before long. We can not alter human nature. In the study of language we have an opportunity to meet and recognize the friends whose acquaintance we first make through the dictionary, and the subsequent encounters

follow the line of our natural instincts. If we fail to recognize one of our word-acquaintances, the request for a fresh introduction comes from our *own side*. Does not the more informal discussion of chemistry in the class-room furnish just the sort of opportunity we require for continual repetition without boredom? Is the almost limitless repetition of language study one bit more than is necessary? Can we then afford to do with any less amount of it in studying a science? Can we afford to turn into lectures any of the all too few hours available for exercises in repetition and interrelation?

Finally, the student in a lecture course must *follow successfully* or he is lost. The lecturer is not a phonograph. He can not be turned back, so as to repeat the exposition of the idea which has somehow missed one of its marks, or to reproduce the key word which the student has somehow failed to catch. Extraordinary variability in the speed with which different individuals apprehend the same thing is one of the most conspicuous qualities of a group of human minds. Naturally the *lecturer* must set his speed to suit the pace of the slowest members. When the work is conducted in such a way that home preparation can not be avoided, as it easily can be, and is, for most lectures, the variable factors are eliminated from the class room and relegated to the study. Each student takes whatever amount of time is necessary for mastering the assigned lesson. And the assemblage which presents itself to the instructor is therefore of more nearly uniform quality.

If we had attempted to devise some method which should run contrary to all the conditions for successful undergraduate instruction, we could hardly have invented a scheme which would be more certain to fail than that I am discussing.

The main point is that we learn only by our own efforts, and not by watching the efforts of others. Some one has said that the college is a "gymnasium where the faculties of men are exercised and developed, rather than a boarding house where the students are crammed with facts." We develop physical muscle by *exercise*. Is there any other way of developing mental fiber? Can we ever cause mental fiber *to develop* by dealing out ready-made ideas: it is a psychologically impossible process. Is any one under the illusion that the fifteen thousand spectators at a football game get any perceptible physical exercise out of watching the performance of the teams?

The college course is to teach the student to *solve problems*. Let us beware of a method of instruction in which the facts are found, not by the student, but by the professor; in which they are arranged and related, again by the professor; in which the conclusions are drawn, by the professor; and the conclusions are finally tested, not by the student, but by the instructor. If by this process we manage to hypnotize the student into thinking that he has acquired the ability himself to solve problems, there will be a rude awakening when the time comes for him to solve problems without assistance.

A METHOD FOR TEACHING CHEMISTRY

To be more concrete, it seems to me that the following are the conditions for the teaching of college chemistry:

First, the laboratory and class-room work must run parallel with one another throughout the year, and the same subjects must be treated simultaneously in both. When separation occurs, the total "yield" is reduced to an astonishing extent, and conversely.

Second, specific laboratory exercises must

be assigned for each week. Punctual performance of these exercises must be insisted upon. The laggards must begin each week with the work of that week, before making up any leeway. Enthusiasts who would go ahead, and finally reach a point where they are performing experiments five or six weeks before they are to be discussed in the class room, must be restrained by force.

Third, the subjects for the class-room discussion must be assigned *in advance,* either from the laboratory experiments, or from the text-book, or both, and due preparation must be insisted upon in every instance. To insure preparation, a question susceptible of very brief treatment, yet dealing with some significant point, may be set at the opening of the hour. After five to ten minutes, the answers are collected, and later they are read, marked and returned. Such questions may be set at any class meeting, and as often as is necessary to secure regular preparation. The subject of the question, being now uppermost in the minds of the student, forms the best starting point for the subsequent discussion. In this way, a section containing as many as fifty to eighty students may be handled.

If the chief instructor has not time to conduct the whole of the work, *this,* the discussion or recitation, is the part of it from which his presence can least be spared. Here is the opportunity to use the maximum of knowledge, alertness and resourcefulness. Here is the place where the student shows how far he has been able to put together ideas for himself. Here is the place for repetition and interweaving. Here is the place for final removal of all difficulties and for distilling from the subject the last drop of instruction that it can yield.

During these exercises the usual demonstration experiments are shown at appropriate points.

By this arrangement the student can not feel that the laboratory work is for the acquisition of mechanical skill, or for the belated illustration of something mentioned in a past lecture. He is made to feel that it is a necessary and valuable part of the preparation for the class-room work—which is conducted so that the method of converting laboratory experience into chemical knowledge is made plain. Problems turn up unsought. The pupils have acquired at least the routine knowledge in the laboratory and at home, and the solving of the problems is almost the only thing that remains to be done in the class room. The whole time of the instructor is therefore devoted to teaching problem-solving.

I am offering these suggestions merely for what they may be worth. I have no desire to dogmatize in regard to details. I merely submit the almost self-evident proposition that the lecture-method can never play any appreciable part in training people to solve problems for themselves. Laboratory work, if dissociated from class work, will never do it either. A system which exacts continuous and thorough home-study, both of the text-book and of the results of the laboratory work, and provides for the maximum amount of the most skilfully conducted discussion of the results that can be provided, stands a strong chance of awakening and bringing to a high state of perfection this, the most essential of all the elements in the mental equipment of a human being.

If the instructor feels, for any reason, that lectures must be given, then many of the most serious defects of the system may be remedied by assigning the subjects in advance for home study, and setting a written question as described above. The whole process consumes ten minutes, but the preparation it entails makes possible the covering of nearly *twice* as much ground in the remaining forty-five minutes. Much

of the merely descriptive matter can be omitted, and the shorter explanations suffice.

SUMMARY

To return to our thesis: the college can reconstitute itself an indispensable and successful factor in American life if it will devote itself, *and confine itself,* to pre-professional work—specific work in preparation for the learned professions and for business—and if it will devote itself, *and confine itself,* to turning out men and women able to solve problems. I think we must be ready to admit that, to do these things, the college requires, and should have, a more definite source for skilled teachers, and that the college must vastly improve the methods of instruction in many of its subjects. If we as chemists can devise a method for training teachers of chemistry and can improve the methods of teaching the science themselves, we shall not only have done a service to the science, but we shall have contributed our share towards the rehabilitation of the American college. Perhaps we can do more than our share, if we are right in feeling that chemistry, appropriately taught, can furnish quite exceptional training in the art of problem-solving. We can make our contribution doubly welcome and doubly valuable if we are willing to tackle the problem at once and resolutely by scientific methods, and to put our solution quickly into practise.

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COLLEGE CHEMISTRY BEYOND THE ELEMENTARY COURSE[1]

Since the character of college chemistry beyond the elementary course is determined to a great extent by the nature of the introductory work, one is compelled in a discussion of this kind to make certain suppositions concerning the nature of an elementary course, and to proceed upon the basis of these assumptions.

Toward the close of the first year, by imperceptible gradations, the course in general inorganic chemistry is often allowed to flow into routine analysis. I can not help feeling that this is especially undesirable. The practise materially shortens the course in general chemistry, and takes for its own uses time which might be spent with greater profit in the study of many properties of the metals which are more varied in character than the limited number usually chosen by the analyst for the purposes of testing and identifying these same elements.

If the elementary course has given the student a somewhat thorough preparation in general inorganic chemistry—a full year with the usual number of hours of recitation, lecture and laboratory work—the college student comes to his second year with the following customary divisions of chemistry before him: Qualitative analysis, quantitative analysis, organic chemistry, physical chemistry.

It would lead me too far afield to consider all of the courses which follow the student's elementary training; so I have chosen to limit my remarks to those courses only which lie in these divisions immediately beyond the course in general chemistry.

Among these divisions, qualitative analysis in the majority of cases is the one which may most profitably be made the successor of the first year of chemistry, provided, of course, this subject is approached from the proper standpoint. I fear, however, that many of our colleges, even to-day, have not emancipated themselves from the old method of teaching this subject, but are

[1] A paper read before the Section of Education of the American Chemical Society at Detroit, July, 1909.

still employing a plan which, although almost universal not many years ago, is now obsolescent. I refer to the purely mechanical process in which great emphasis was placed upon the art of making tests and separations, while the teaching of sound chemistry was a matter of minor consideration.

Under this régime, instruction in the laboratory usually fell into a routine and complacent following of some outline of analysis carefully arranged with side margins and pages with indented leaves for ready reference. The group separations were accomplished by unswerving adherence to certain tabulated schemes which demanded a minimum of mental exertion, and afforded a striking example of a "principle of least work." It was no uncommon thing to require a student to analyze one hundred "liquid unknowns," one hundred "solid unknowns" and forty minerals arranged in a row. The desired end was reached if the student, at the request of an instructor, could make a correct report of the "acids" and "bases" which he had found in each unknown.

The text-book frequently contained page after page of those incomplete equations in which the right-hand member was to be supplied by the student. This was often done in a successful way by the precarious process of analogy; but in many cases there were several guesses equally plausible, and the student generally made his choice without any effort to find out the facts in the case. When I think of the vagueness of these equations, I am reminded of a question which, I have heard, was once proposed to a class in history at an examination. It read, "Who chased whom how many times around the walls of what?" The answer to this question was probably more certain to be correct than the answers to be expected in the case of the fragmentary equations of the kind I mention.

If by chance any recitations were attempted in connection with this ineffective course, they usually degenerated into mere droning of equations, sometimes in unison, like a chant. In other words, the essential rôle of the course consisted in an endeavor to master the details of the manipulative art, with the result that the science underlying it was sadly neglected to the great detriment of the student who usually knew less chemistry at the end of his course in qualitative analysis than he did at the beginning of it.

To my mind, a course in qualitative analysis first of all should be designed to teach advanced general chemistry; in the second place it should aim to teach the necessary manipulative skill, a knowledge of which, I confess, is of the utmost importance for success in chemistry. The golden threads of physical chemistry have so intertwined themselves in every fiber of the warp and woof of general inorganic chemistry, and have so illumined the problems of analytical chemistry at every turn that there is no longer any excuse for making the subject matter of qualitative analysis profitable to the student mainly in the direction of acquiring laboratory technique. Such a course should furnish the teacher a most fortunate opportunity for presenting to the student certain views of general chemistry in a manner more advanced and more forceful than the latter has ever met them before; and should serve at the same time as a means of relating and fixing facts which, up to that time, may have been unrelated and vague.

I have in mind a course of recitations with lectures, so arranged that points taken up in the class-room shall be illustrated again and again in the laboratory practise

through the solution of definite problems suggested by the analytical operations themselves. The lectures should be very largely experimental, and might consider, among other things, the logical sequence of the most essential facts which led to the proposal of the theory of solution; the experimental basis for the hypothesis of ions and the theory of electrolytic dissociation; the significance and application of the laws of chemical equilibrium (homogeneous and heterogeneous) with illustrations chosen from the wealth of material furnished by analytical processes.

As an outcome of the discussion of the nature of chemical equilibrium, the student will be in a position to consider certain topics—the methods of deriving dissociation constants may be presented briefly, and the value to the analyst of a knowledge of these constants may be dwelt upon at some length; the problem of the solubility product may properly take some time, since there will be little difficulty in making its value and application plain by selected experiments, many of which the student himself may perform in the laboratory; the study of complex ions and their stability constants will furnish abundance of material for experiment and discussion. These few main points may serve to suggest the changes so greatly to be desired in the teaching of this division of chemistry in the colleges.

It is here that the subject matter of elementary physical chemistry and analytical chemistry overlap, and the one takes from the other certain chapters which may be of practical service to it in the successful elucidation of its particular problems. By this overlapping, qualitative analysis has ceased to be governed largely by rule of thumb, and has passed into an organized and orderly subject with that real "scientific foundation" prophetically announced by Ostwald a number of years ago.

What I have said concerning qualitative analysis applies with equal force to quantitative analysis. It must be admitted that the laboratory art is exceedingly intricate and varied, and should be thoroughly learned. When, however, the student is permitted to devote his entire time to it, except for interruption by a single weekly recitation on problems, the loss to him is irreparable.

As regards elementary physical chemistry there is little to say, since there are very few colleges which give any definite course in this subject, unless a course in theoretical chemistry is made to serve this purpose also; but it is doubtful whether the courses given under this title deserve to be classed as physical chemistry in the present sense of the term. There can be no question as to the desirability of such a course as a part of the college curriculum; its appearance in certain college announcements gives us hope that others may follow.

The recent changes which I have mentioned in connection with the teaching of analytical chemistry have gradually found an entrance into the methods employed in some institutions, and may be looked upon as fairly established in many quarters. With the teaching of organic chemistry the case is different. I believe that this division of chemistry is in a transition stage with respect to the content and character of the subject matter presented in the elementary course.

It is generally conceded that qualitative analysis ought to be the course which should follow logically upon the heels of the elementary course. In fact, this practise has been in vogue for so many years, and has been advocated by so many famous teachers that it has come to be looked upon as a matter of necessity, rather than choice. This, however, is by no means the case. For many years, organic chemistry has formed rather a mature part of a stu-

dent's course, and, in its advanced phases, must do so still. But there has come to be an increasing need on the part of students for this division of chemistry as a prerequisite for certain professional and scientific courses to follow; this has made it almost a necessity to insert organic chemistry immediately after the elementary course.

This juxtaposition has made the teaching of elementary organic chemistry a more difficult problem than it was, and has placed the teacher of this subject in a somewhat unfortunate and unenviable position. Those of you who have taught this subject are very well aware that the student is in the habit of approaching the course in organic chemistry with misgivings; it is proverbially a hard task, and is tabooed as "no snap." It seems to me that organic chemists have themselves to blame for this attitude. Let me cite one or two instances which may serve to justify this claim.

In the first place, the methods which were in vogue at a time when organic chemistry formed a more advanced part of the college curriculum have not been modified sufficiently to adapt it to the student at an earlier stage in his career in chemistry. As an illustration of this kind of fault, let me mention the universal practise of prefacing the systematic study of the various classes of organic compounds by a very detailed description of the quantitative methods of organic analysis. Instead of this, a brief statement of the essential principles would suffice. Except in a general way, these longer directions, still in use, are rarely comprehended by a student who has not taken quantitative analysis, and at the very beginning, they tend to create discouragement and discontent which could be dispensed with by applying a little sound pedagogy. Such remnants of earlier times and methods have no more justification at this stage than a minute description of every precaution necessary in the quantitative estimation of manganese would have as an introduction to a discussion of the compounds of manganese in a course of general inorganic chemistry. Numerous instances of this atavism are to be found in the elementary text-books of organic chemistry; there is little reason to doubt that they occur in the lectures as well.

A second and graver difficulty lies in the fact that there has come to be a widening gap between the methods employed in approaching the subject matter of general inorganic chemistry and the methods which we must believe are still not far from universal in attacking the problems of organic chemistry in an elementary course. Thanks to the timely warning of physical chemistry, and the practical example furnished by a few text-books of general inorganic chemistry, we have made a grand stampede to return once more to the facts of our experience as a basis of procedure. We have endeavored here to strip off much of the speculative husk which has encased the subject with almost impenetrable firmness. In this desirable simplicity, we are content to call a stone, a stone, and to name a flower, a flower. In the teaching of inorganic chemistry, this movement has demanded the wholesale striking out of intricately constructed graphic formulæ which had no serious or certain justification in facts, and therefore explained nothing. As a result, the other extreme has now been reached, and scarcely any of the reactions and relations considered in an elementary course of inorganic chemistry are presented to the student in this symbolic garb.

On the other hand, the organic chemist, up to the present time, has had little or no success in presenting his subject from an

inductive standpoint. The old genius is too strong, and stands menacingly by while he writes. Several text-books have made a bold start with this object in view; but after a brief beginning of little promise, the argument rapidly assumes the old dogmatic form. Substances are said to be aldehydes "because they contain the aldehyde group"; or unsaturated, "because they possess double bonds." At every turn, the chemical and physical properties of compounds are attributed to them as a result of certain "constitutions" or "groupings of the atoms within the molecules." Rarely, if ever, is the veil lifted, and the student permitted to see that, as a matter of fact, precisely the reverse order is the one which should hold, and that it is the physical and chemical properties which determine the constitution. It is a matter of some surprise that we do not hear of compounds with good constitutions, and of others, in pathological conditions perhaps, with bad constitutions. After an explosion of nitroglycerin, it would seem to be quite in keeping to hear that the compound unfortunately had ruined its constitution.

Since this difference of method has grown up within these two divisions of chemistry, it has come to pass that students, thrust suddenly into the field of organic chemistry, find themselves lost in a maze of symbols, formulæ and nomenclature. Since the elementary inorganic course at present has abandoned the use of graphic formulæ almost altogether, the student does not receive any discipline of that part of his mind which, for want of a better name, may be called his formulæ-comprehending faculty, and, in consequence, is at a loss to find himself in this unexpected confusion. No assistance is furnished him by the elementary texts of organic chemistry, because these volumes still take it for granted that the student has practised atomic gymnastics of the kind in favor some thirty years ago.

It seems to me that the teaching of elementary organic chemistry must soon undergo a radical change, perhaps a revolution. I believe this advance is developing at the present time. Let us return to the basis of experimental facts and observations, and let us state our theoretical conclusions with these fully in the foreground of our thoughts. There is no difficulty in presenting to the student a set of facts determined by experiment; and there is no impossibility in bringing him to see how these facts may be expressed, in part at least, by properly chosen symbols in terms of certain hypotheses and theories. The modern text-book of organic chemistry remains to be written; it will view the subject from this point of vantage.

In his memorable address before the German Chemical Society on the occasion of the celebration in his honor, held in 1890, Kekulé gave the well-known account of the origin of the theory of the benzene ring, and at the close of this account said, "Let us learn to dream, and then perhaps we shall find the truth . . . but let us beware of publishing our dreams before they have been put to the proof of the waking understanding."

Lauder William Jones
University of Cincinnati

How can the Bureau of Education help the City Superintendent of Schools?

Among the questions which the Country Life Commission asked in its hearings in the several parts of the United States which it visited was: "In what way can government help in the work of public education?" The question generally evoked two types of answer. The one,

Government can do nothing; each community must work out its own educational salvation; we must wait for the people to act; they should have the kind of schools that they want, and they should be free to develop educationally as fast or as slowly as they may care to; the whole matter of education should be left to them.

The other type of answer was diametrically opposed to this. It ran:

Government can and must help in the work of education; the nation has done much, but what it has done is all too little compared with what should have been done in promoting school work. We are told—and it is an accepted dictum of American life—that the very existence of the nation depends upon the spread of education among its people. Yet works meet for such a faith have not been produced at Washington. The federal government has consigned its chief interest to the care of a bureau, and has accorded to the titular head of all the educational work of this great country the dignity of a bureau chief. The authority of the United States Commissioner is even less adequate, for in his last report we read: "The Bureau of Education is peculiarly dependent upon the cooperative spirit among the school officers of the country, for it can only ask for information, which is given voluntarily or not at all." The initiative of local communities, and of the states in some cases, acting as a whole, has produced a variety of educational means, method, plans, systems, institutions, results. The nation spends vast sums in them, but there is too little coordination of all this work, too little wise planning and expert counsel, to accomplish the results which should be accomplished. Government should help by creating an agency to coordinate, encourage, initiate and oversee the educational activity of the entire land. The next great step in the advancement of learning among the American people is to enlarge and safeguard its interests, by giving the Commissioner of Education the rank and the authority of a secretary in the President's cabinet.

There is something to be said for both these points of view—much more, we think, for the latter than for the former. The interests of education are momentous. Its activities are so chaotic that it must have a pilot to direct its course. Dr. Draper has shown conclusively that a federal educational plan is needed, in order that the national government may more efficiently administer the educational undertakings and responsibility which are now parcelled out among a number of government officers. He has called upon the nation to use the educational office which it has created, and not to neglect and belittle it, but rather to make of it an educational organization worthy of such a people. President Pritchett has called attention to the confusion and false pretense which rub elbows with the standard work of standard institutions in the field of the higher education, and has pointed to a work of standardizing and criticizing and evaluating college and university incorporation, instruction and degree-giving, which must be done by the national government, if it is to be done at all. The national university at Washington is a project which will not down. What is most needed to bring it into being is a national educational agency, with sufficient authority to pass upon the nation's need for such an institution, and adequately to plan for it in whatever form it is needed. Without some guiding authority to shape it, it is certain to be a many-headed compromise, born of committee deliberations, rather than the powerful head of the nation's educational work, which only a responsible authority can make it. In other countries, the interests of education and the fine arts are generally regarded as so completely indivisible that they are committed to the care of a single minister of public instruction and the fine arts. So should it be here, and the same unity of interest should be recognized by educational and artistic forces everywhere throughout the land.

In addition to the administration of the educational work, which is already under the care of the nation, the standardizing and inspecting of the higher instruction of the country, the propagating of a national university in whatever form may be determined as most desirable, and the fostering of the fine arts as a function of government, there remains for the Secretary of Public Instruction and Fine Arts the work of maintaining a national clearing house to further the activities of primary and secondary education throughout the land. Like the Department of Agriculture, it should be a center for the com-

parative study of school work, and a distributing point of scientific knowledge upon every phase of education. It should be a consulting bureau. Like the Department of Labor, it would assist whenever needed. Strict uniformity of educational practise is certainly far from desirable, but greater uniformity than now obtains would just as certainly be for the best interest of all concerned. The department would be a center of inspiration and leadership for all who are concerned in the educational development of our nation. Besides, its expert help and its expert advice should constantly be available whenever and wherever needed. It should do the work of educational investigation and reporting which the Country Life Commission is now doing in regard to the sufficiency of the rural schools. It should plan for their improvement, and should be largely directive in shaping the educational features of such a far-reaching measure as the Davis bill.

As John Stuart Mill pointed out, experimentation, generalization and the formulation of laws for human guidance in the social realm are much more difficult than in the sphere of physical nature; for in social experimenting, the conditions can not be reproduced at will, and the laboratory, which furnishes the facts upon which the inductions of the moral sciences must be based, is the world. Correspondingly urgent is the need for special provision for furnishing such assistance and guidance as a thoroughly furnished central agency of the national government could give to its large and continuing educational activities. That there is here a specific field for governmental activity, the organization of other governments sufficiently proves. The fear of over-centralization through such a department is but a nominal objection to its existence. Agriculture is not centralized or nationalized by being promoted and encouraged by a Secretary of Agriculture. Neither is commerce. But agriculture has profited enormously through the assistance of the department at Washington. Education should profit in the same way. Political control would not interrupt the work of such a department more than it interrupts the work of the other departments of the national government. Indeed, the national government, through its civil-service standards, and its civil-service propaganda, should be able to lend very material assistance in taking the schools out of politics, and in substituting civil-service methods of appointing teachers for the political give and take which, but for assistance from without, bids fair to dominate public school work for some generations to come.

In reply, therefore, to the question, How may the work of the Bureau of Education be expanded so as to aid the city superintendent in his work? I would answer, first, by greatly increasing the power and authority of the office, by promoting the Commissioner of Education to the highest possible position of leadership which the nation can create, and thus giving to school officers of every grade the fullest aid and encouragement which the national government by its example as well as by the thoroughly expert assistance at its command, can render. Not only will the educational arm of the public service be dignified, the esprit de corps of the teaching profession itself will be improved by taking on something of the strength of organization which it has under the governments of the old world. A city superintendent of schools in any one of the larger cities of America is frequently forced to fight an unequal battle against the conditions that war for the undoing of education, simply because there is as yet no sufficient professional support in the land for the educational ideas which he is called upon to defend. No voluntary organization of teachers, no unofficial propaganda for education, no official assistance which a state government is able to render, can have the strength and effectiveness which the national government can command in promoting and intensifying the educational sentiment of the country. The city school systems are called upon to lead in educational invention and readjustment and reorganization of work. Of consulting agencies whose aid they may invoke there are practically none save the officials of other school

systems, whose eyes are usually turned inward upon their own work, and university departments, whose knowledge of ways and means is by no means complete. The educational office at Washington can be of the greatest service by continuing to do what it is already doing so well, viz., to publish carefully prepared bulletins upon current educational problems. Its recent bulletin upon the apprenticeship system in the United States furnishes a preliminary survey of the field which had to be made before plans for industrial training could be made with knowledge and with certainty. But there are 10,000 questions which school officers will want to ask, and not a few expert opinions which will be required, and some special studies even which they will want made before instruction along industrial lines can be reduced to school terms, and properly launched as a subject of study. There are a myriad of points upon which expert opinions are wanted, such as one may get in medicine or in law, when in need of them, but which education has not as yet formulated a definitely satisfactory means of supplying. For illustration, Should education and school management be a matter of state supervision and control, or should they be left to the care of the community alone? This is the old question of a state system *versus* local organization of schools, but it is not a moot question, for school systems are being reorganized daily, and it must be that experience and use have shown that these plans are not equally advantageous. Again, what is the proper relation of a city school system to the municipal government of the same territory? The court of appeals of New York State has declared that it is "the settled policy of the state, from an early date, to divorce the business of public education from all other municipal interests or business." Can public education endure unless it maintains this independence of purpose, function and control? And yet the rapidly-growing cities of the country are allowing their school departments to be annexed to the city hall so completely and so rapidly that freedom to do an educational work bids fair to disappear in many parts of the country. Shall the city board of education fix the amount of money required for school purposes each year, or shall the most corrupt and most inefficient of American institutions, the city government, do it? It makes a vast difference in the effectiveness of a school department how this question is answered, though the total tax rate may remain the same. School departments now segregate their expenses and statistics in one way for the commissioner at Washington, in another for the state superintendent; and sometimes in a third for the city authorities. The Commissioner of Education is attempting to reduce this chaos to order by securing the adoption of standard forms of school reports; but this necessary reform is greatly hindered by the fact that the acceptance and use of such standard forms must be a purely voluntary matter, as the commissioner can not require it. The Bureau of Education could be of very great service by standardizing the different kinds of charges which should be regarded as legitimate claims against the various school funds. As, for instance, What items are proper charges against a public school building fund, and what must be charged to contingent funds? Is new furniture put into an old building to be charged to one, or the other? How about the remodeling of buildings to make escape from them easier in case of fire? Must this be classed as repair work, or as building? Neither the laws nor the decisions of the various states are quite specific upon such points. The need for uniformity of practise is not so much that the proper charges may be made, but that, having been made, caviling critics may not be able successfully to attack them. There is a national municipal system of bookkeeping which unofficially is doing for cities what a similar system worked out by the Bureau of Education should do for the accounting of the schools. What are the health measures which a city school system should undertake? How can it best proceed to enforce the compulsory education law, and bring all its children into school? What responsibility should it assume for the child-labor law? How can it assist in preventing juvenile delinquency? What part

can it take in the work of promoting the general welfare of children? Besides there are ever with us the great questions of the course of study and methods of learning—the what and the how of teaching. In collecting and reporting the more successful experiments which are being made in the schools of any part of the world, the Bureau of Education is doing an incalculable service in making well-established scientific formulations of education possible. Special help is needed in the study of ways and means for the teaching of morality and the elements of law that no child may grow up without being well grounded in the knowledge of the fundamental relations of human beings. The office of the Commissioner of Education has always been wisely and ably administered. It has been of immense assistance in promoting education in the United States. It is reaching out to a larger work. The time is ripe for it. But to do it, the Bureau of Education must have larger appropriations, more experts, and above all, a much larger authority and function in the service of the nation.

E. C. Moore

Los Angeles, Cal.

WATER VAPOR IN THE ATMOSPHERE OF THE PLANET MARS[1]

An expedition from the Lick Observatory, University of California, was recently sent to the summit of Mt. Whitney, the highest point of land in the United States, through the private generosity of Regent Wm. H. Crocker. It had for its purpose to study the question of water vapor in the atmosphere of the planet Mars. The instruments consisted of a sixteen-inch horizontal reflecting telescope and a suitable spectroscope. The observations, made on the nights of September 1 and 2, were mainly photographic.

Water vapor in the atmosphere of any planet causes dark bands to be formed at certain definite positions in the spectrum of that planet; conspicuous bands if the water vapor is abundant; inconspicuous bands if the quantity is slight, as this, the only method known, is not a sensitive one.

The observer of Mars must look up through the earth's atmosphere; and the great quantity of water vapor in our atmosphere, if the observer is near sea level or at ordinary altitudes, blots out the effect of any Martian vapor, making a solution of the problem impossible. By ascending Mt. Whitney, altitude 14,501 feet, the Crocker expedition placed itself above probably four fifths or more of the earth's water vapor. Further, the air on Mt. Whitney was astonishingly dry during the time of the observations. With barometer 17⅜ inches, air temperature 29 degrees Fahrenheit, and wet thermometer 17 degrees, students of the atmosphere will recognize that the observers of Mars were looking through remarkably little terrestrial water vapor. Even this small quantity would be almost fatal to success if we did not have a fairly satisfactory method of eliminating its effects, as follows: Our moon has no appreciable atmosphere. The lunar and Martian spectra will be affected alike by the water vapor in the earth's atmosphere. These spectra are photographed, one immediately after the other while the conditions in our atmosphere remain unchanged, and with the moon and Mars at the same altitude above the horizon so that their rays traverse equal paths in our atmosphere. If the vapor bands in the Martian spectrum are found to be stronger than in the lunar spectrum, Mars has water vapor in considerable quantities. If the bands in the two spectra are equally strong, water vapor on Mars does not exist in sufficient quantities to be detected by the spectroscopic method. The latter condition was found to exist, when this method was applied under the superlatively favorable conditions existing on Mt. Whitney. Both spectra were photographed when Mars and the moon were near the horizon, again when they were at medium altitudes, and finally when they were 49 degrees above the horizon. The best vapor band, technically called "a," was faint in both spectra when the bodies were low, fainter when the bodies were higher, and very faint when the bodies were at their highest; but for equal altitudes the "a" bands in the Martian and

[1] Statement by Director W. W. Campbell, of the Lick Observatory, prepared for the Associated Press.

lunar spectra were equally intense; plainly signifying that the observed bands were due to water vapor in the earth's atmosphere above the summit of Mt. Whitney. This does not mean that Mars has no water vapor, but only that the quantity present, if any, must be very slight. Let us recall that we see Mars by reflected sunlight. The rays which reached our instruments passed from the sun into the Martian atmosphere, for the most part down to the surface of the planet, and then out again to us, thus passing twice through the planet's atmosphere and any water vapor it may contain. Even with this multiplying effect on Mars the vapor bands in the Martian and lunar spectra were alike, and we conclude that any water vapor in the Martian atmosphere must have been much less extensive than was contained in the rarefied and remarkably dry air strata above Mt. Whitney.

These observations do not prove that life does not or can not exist on Mars. The question of life under these conditions is the biologist's problem rather than the astronomer's.

SCIENTIFIC NOTES AND NEWS

DR. IRA REMSEN, president of the National Academy of Sciences, has consented, at the request of Dr. H. F. Osborn, president of the American Museum of Natural History and Mr. Archer Huntington, president of the American Geographical Society, to appoint a scientific commission to examine the records of Lieutenant Peary and Dr. Cook, in case they are ready to present them to such a commission. Lieutenant Peary has accepted the suggestion, and it is reported that Dr. Cook will under certain conditions also accept.

THE mayor of Baltimore has nominated Dr. William H. Welch, of the Johns Hopkins Medical School, as a member of the new charter commission.

THE University of Manchester has conferred an honorary doctorate on Dr. Otto Wallach, professor of organic chemistry in the University of Gothenberg.

AN international committee has been formed to celebrate the fortieth year of university work of Professor Henrico H. Giglioni, professor of zoology at Florence.

MR. R. PRIESTLEY, who left University College, Bristol, to join Mr. Shackleton's Antarctic expedition as geologist, has left England for Australia on October 22. He intends to join Professor Edgeworth David, F.R.S., at Sydney University, to work up the geological results of the expedition.

WE learn from *The Journal of Terrestrial Magnetism* that the Norwegian Storthing has voted to Professor Birkeland 5,000 kroners annually for four years, making a total of 20,000 kroners (about 5,300 dollars), thus enabling him to continue the publication of his investigations on magnetic storms and polar lights.

PROFESSOR CHARLES JOSIAH SMITH, of the chair of mathematics of Western Reserve University, has been given leave of absence for the year.

DR. CHARLES H. MAYO, of Rochester, Minn., will deliver two lectures at the University of Maryland, on November 9 and 10, on "Diseases of the Thyroid Gland," and on academic day he will receive from the university the honorary doctorate of laws.

ON the opening of the graduate school of the University of Pennsylvania, on September 30, Dr. Thomas H. Montgomery made an address on "The Making of the Investigator."

MR. JOHN BIRKINBINE, president of the Pennsylvania Forestry Association, will give a lecture at Lehigh University during the present month on "The Relation of the Engineering Profession to Forest Preservation." This lecture and others have been made possible by a special gift for increasing interest in forestry.

THE valuable scientific library of the late Professor Simon Newcomb has been purchased by Mr. John Claflin for the College of the City of New York.

THE death is announced of Dr. Anton Dohrn, founder and director of the Biological Station at Naples, and eminent for his contributions to zoology.

DR. MAX HEINZE, professor of philosophy at the University of Leipzig, known for his important publications on the history of philos-

ophy, died on September 17, at the age of seventy-three years.

Mr. Bryan Cookson, assistant at the Cambridge Observatory, has died at the age of thirty-six years.

A bronze tablet, three by two feet, has been installed in the building of the New York Aquarium, it being the New York Zoological Society's contribution to the Hudson-Fulton Celebration. The tablet is inscribed:

This building first known as West Battery, erected 1807–1811—Called Castle Clinton after the war of 1812—Ceded by Congress to New York City 1823—Subsequently known as Castle Garden —General Lafayette received here 1824, President Jackson 1832, Kossuth 1851, the Prince of Wales 1860—Jenny Lind first sang here 1850—The landing place of eight million immigrants, 1855–1890 —Connected with the land by a bridge prior to 1869—Converted into an Aquarium 1896—Placed under control of New York Zoological Society 1902—Aquarium visitors twenty-one million to 1909.

The last legislature of North Dakota passed a comprehensive pure seed law intended to regulate the sale of agricultural and garden seeds, providing for proper labeling of such seeds, and for the establishment of a Seed Control Laboratory at the North Dakota Agricultural College, in connection with the department of botany. Dean H. L. Bolley was made state seed commissioner and Mr. Orin A. Stevens, of the Agricultural College of Kansas, was elected assistant in charge of the laboratory. The laboratory is well equipped for all types of seed investigation and opened for work on October 1.

At a meeting of the board of directors of the American Chemical Society held at the Chemists' Club, New York, on September 13, it was voted that an additional amount not to exceed seven hundred dollars be appropriated for the purposes of the *Journal of Industrial and Engineering Chemistry* for the balance of the fiscal year provided that no issue of the journal to which this appropriation is to apply shall exceed sixty-four pages exclusive of advertisements and cover. The amount of material offered for publication having become so great, it was voted that the directors recommend that the editors of both journals should not feel obliged to print all matter that passes their respective boards, but should conduct their journals from the standpoint of those who read rather than from that of those who write, making a selection of those articles which, having passed their boards, are in their opinion of the greatest value to chemical science and industry.

The London *Times* states that a group of French, German and Belgian patrons of aviation are offering a prize of 250,000 f. (£10,000) to be awarded to the aviator who rises, with a fixed point as center, to a height of 250 meters, flies a thousand meters from this altitude in a horizontal direction, and finally, returning, soars for a quarter of an hour at a height of 20 meters over the point of departure. An alternative feat is to make a flight from Brussels to Paris or from Brussels to Cologne, without a stop, at a speed of 60 kilometers an hour. At Spa the final preparations for the competition have now been made, and MM. Paulhan, Sommer, Druet, Delagrange and Le Blond have their machines ready in their sheds for the trials.

The New York *Evening Post* states that Dr. Paul Vouger, of the Museum of Neuchatel, Switzerland, has given the archeological branch of Peabody Museum, of Yale University, two cases of prehistoric implements in stone, iron, horn and bronze. A collection of Indian antiquities has been received from G. W. Rittenour, '09. By an exchange there has been received from Stockholm, Sweden, an ethnographical collection made among the African tribes of the Congo. From the Egyptian exploration fund has come a collection from the tombs at Mahaska and Abydos. It includes articles in ivory, vases, beads, ornaments, palettes and pottery.

In the Public Health Reports for August 27, 1909, appears an article on "Plague among Ground Squirrels in Contra Costa County, California." In 1894 plague began to spread from central Asia. Since then it has been carried to practically all parts of the world, including the Pacific Coast of the United States, where the disease has appeared in man,

in rats and in ground squirrels. The infection in ground squirrels has so far appeared in Contra Costa and Alameda Counties, California, chiefly the former, where, up to September 10, 1909, 220 plague-infected squirrels had been found. The Public Health and Marine-Hospital Service is attempting to destroy all the ground squirrels in the involved area, or at least to so reduce them in number that the plague infection among them will die out of its own accord. This article gives a detailed account of plague infection among the ground squirrels in Contra Costa County, and the relation of squirrel plague to plague in man. It also describes the means employed for the destruction of the squirrels, and gives a serial list of infected squirrels with the location where found. The article has been reprinted, and a limited edition is available for distribution to those interested. Requests for copies should be made to the Surgeon-General, Public Health and Marine-Hospital Service, Washington, D. C.

A BILL to promote the economic development of the United Kingdom and the improvement of the roads was introduced in the House of Commons on August 26 by the chancellor of the exchequer. In the explanatory memorandum, as summarized in *Nature*, it is stated that the bill enables the treasury to make free grants and loans for the purpose of aiding and developing forestry, agriculture and rural industries, the reclamation and drainage of land, the improvement of rural transport (other than roads), the construction and improvement of harbors and canals, and the development and improvement of fisheries, and for many other purposes calculated to promote the economic development of the United Kingdom. A grant or loan must be made either to or through a government department, and all applications for grants or loans have to be referred to an advisory committee, and the recommendations of the committee considered before the grant or loan is made; but the responsibility of making the grant or loan will rest with the treasury, who will not be bound by the recommendations of the committee. All grants and loans will be made out of a separate fund, which will be fed by (1) sums annually voted by parliament; (2) a sum of £2,500,000 charged on the consolidated fund and payable in five annual instalments of £500,000 each in 1911, 1912, 1913, 1914 and 1915; (3) sums received by way of interest on and repayment of loans and the profits made as the result of a grant or loan in cases where the repayment of such profits is made a condition of the grant or loan. Power is given to the Board of Agriculture and Fisheries and the Department of Agriculture and Technical Instruction for Ireland to acquire land (compulsory if necessary) for any purpose for which a grant is made to them. The bill will permit the expenditure of money on scientific research and experimental work of a kind likely to be beneficial to agriculture. The bill further constitutes a Road Board for the purpose of improving the facilities for motor traffic. In addition to the power of acquiring land for the purposes of new roads proposed to be constructed by the Road Board, the board is given power to acquire land in rural districts on either side of any such proposed road to the extent of 220 yards in depth.

UNIVERSITY AND EDUCATIONAL NEWS

HARVARD UNIVERSITY has received $15,000 from Mrs. James Augustus Rumrill, to establish three scholarships.

THE alumni fund of Yale University was increased last year by $73,000, the total fund now being $361,000.

AN anonymous gift of $250,000 has been made toward providing a pension fund for teachers in the public schools of Pittsburgh.

EX-GOVERNOR JAMES D. PORTER, LL.D., has resigned the presidency of Peabody College for Teachers at Nashville, Tennessee, which office he has held for seven years. The duties of the office have been assigned to Dr. J. I. D. Hinds, professor of chemistry, and for several years dean of the college faculty. Dr. Hinds will hold this position until a president is elected by the trustees of the New George Peabody College for Teachers, which is now in the process of organization. Governor Por-

ter retains his position as a member of the Peabody Education Board and chancellor of the University of Nashville.

Major Frederick S. Russell, U.S.A., professor of pathology in the Army Medical School and curator of the Army Medical Museum, has been selected to succeed Dr. Joseph J. Kinyoun as professor of pathology and bacteriology in George Washington University.

Dr. Ross Anderson has resigned as professor of bacteriology and pathology in the University of Utah, and has been succeeded by Dr. Frank A. McC. Jenkin, of the University of Michigan.

At Western Reserve University, instructors have been appointed as follows: John A. Black, A.M., in chemistry; A. H. Ford, A.M., in mathematics; Clinton R. Stauffer, in geology; Davidson Black, M.D., in histology and embryology.

In the medical department of the University of Texas, Dr. Henry Hartman has been appointed demonstrator of pathology and Dr. E. E. Calloway, demonstrator of anatomy.

E. H. Henderson, Ph.D. (Columbia), professor of education and psychology at Adelphi College, Brooklyn, has been transferred to the chair of philosophy.

Dr. S. E. Wolbach has been appointed director of the histological laboratory of McGill University.

At Queen's University, at Kingston, Ont., Dr. W. O. Walker has been appointed associate professor.

Dr. George A. Gibson, F.R.S., has been appointed professor of mathematics at Glasgow, in succession to Professor Jack, who has resigned.

Mr. T. Mather, F.R.S., has been appointed professor of electrical engineering at the City and Guilds Central Technical College in succession to the late Professor Aryton, F.R.S.

Mr. William Brown, B.Sc., lecturer in electro-technology at the Royal College of Science for Ireland, has been appointed, as from October 1, to the chair of physics in the college, which will become vacant on that date owing to the retirement of Professor W. F. Barrett, F.R.S., under the treasury regulations as to age.

DISCUSSION AND CORRESPONDENCE

PROGRESS OF THE INTERNATIONAL LANGUAGE ESPERANTO

On account of the importance of an international language to science, American scientists will undoubtedly be interested in the following bits of information concerning the international language Esperanto. This language was endorsed by the Pan-American Scientific Congress, which met in Chili, and it was recommended that Esperanto be taught generally in the schools.

The International Medical Congress, which met this summer at Buda Pesth, received ten reports in Esperanto.

The International Congress of Psychologists, at its recent meeting in Geneva, admitted Esperanto as an official language, placing it on the same basis as German, French, English and Italian. Four addresses were made in Esperanto at the general sessions.

The report of the ninth International Congress of Geography, recently held in Geneva, has been printed (unofficially) in Esperanto.

The eighth International Congress of Hydrology, Climatology and Physiotherapy, which met in the city of Algiers in April, made official use of Esperanto in its sessions.

The Brazilian government recently published in Esperanto a résumé of the industrial development of Brazil. As any one who is familiar with one or two modern languages and knows a little Latin can easily acquire a reading knowledge of Esperanto in a few weeks, it is suggested that any who are interested in the above report might do well to secure a copy of it. Many other minor notes might be given, showing that Esperanto is rapidly assuming the place which was intended for it, namely, as a means of inter-communication between people who speak different languages.

I may add to the above notes that there is a strong international organization of physi-

cians, of which Esperanto is the official language. Their journal for May consisted of 24 pages devoted to important medical subjects. Thus far, physicians have made more use of Esperanto than any other profession. They realize the importance to medical science of an easy means of communication between men of the profession all over the world and are rapidly coming to make use of Esperanto for this purpose.

Some of the large type foundries of Europe are now prepared to furnish the few special letters required in printing Esperanto, in various styles.

Five international congresses for Esperanto have been held, between thirty-five and forty nations being represented either officially or unofficially in the last three. The sixth international congress for Esperanto will be held in Washington, D. C., in August, 1910.

A strong organization exists in Europe, with headquarters at Geneva, for the production of technical vocabularies for Esperanto. The writer has been requested to act as secretary for this organization for the United States. He would be glad to communicate with scientists in all parts of the country who may be interested in this work. It will only be a few years until technical vocabularies will be available, so that all important results of investigations can be printed in Esperanto, and thus become available to the whole world.

The fact that there are eighty-six periodicals published in Esperanto, eight of which are published in the United States, may be taken as an index of the growth of the movement for an international language, a movement which now seems assured. Having taken the trouble to learn the language I wish to assure those who are interested that the amount of labor involved in learning Esperanto is certainly not more than one fiftieth that required to learn German.

W. J. SPILLMAN
U. S. DEPARTMENT OF AGRICULTURE

GEOLOGY AND COSMOGONY

TO THE EDITOR OF SCIENCE: 1. In reply to Professor Barrell's communication in your issue of July 2, 1909, it is sufficient to say that he carefully passes over the legitimate question under discussion, which is that the mountains are formed by the sea, and not at all by the shrinkage of the earth, as taught in most of the books on geology. Since he has thus evaded the issue, his long-drawn-out discussion requires no further notice.

2. In reply to Moulton's statement in your issue of July 23, let me say that my work on the spiral nebulæ and on the formation of the solar system, under the secular action of a resisting medium, was essentially completed July 14, 1908, and my subsequent application for copies of his papers (received here in October, 1908) was simply to enable me to make exact references in some of the arguments refuting his theories. This is well known here, for I was all the while in frequent consultation with members of the astronomical and mathematical faculty at Berkeley, and they were fully informed of the results at which I had arrived. My results were held back for over six months (cf. *A. N.*, 4308), and so new did the conclusions appear to the astronomers of the Pacific coast that when my paper was given to the Astronomical Society of the Pacific, January 30, 1909, several of them stated in public interviews in the San Francisco papers that they were exactly the opposite of previous theories.

3. In the *Astrophysical Journal* for October, 1905, Moulton develops a theory that spiral nebulæ are formed by one star passing by another, and causing spiral ejections of prominences under tidal forces. This idea seems to have originated with Chamberlin, as outlined in his paper on the "Function of Disruptive Approach, etc."[1] Here are some of the arguments against these Chamberlin-Moulton theories: If such tidal disruptions were in progress, spiral nebulæ would be prevalent in the Milky Way, and above all in globular clusters; such is not the case. Perrine has recently shown, in Lick Observatory Bulletin No. 155, that the globular clusters are quite devoid of nebulosity of any kind. Lastly, if spiral nebulæ are due to the disruption of one star by another, then both stars would usually be disrupted in passage, and spiral nebulæ should

[1] *Astrophys. Jour.*, 14, 17–40, 1901.

thus occur in pairs, which is not a fact. This theory of spiral nebulæ is therefore directly contradicted by the most obvious phenomena of the heavens.

4. In the same number of the *Astrophysical Journal* it is announced that Saturn's ninth satellite, *Phœbe,* can not now escape from the control of the planet, so, "conversely, it has never come under Saturn's control from a remote distance." Of course this interpretation of the use of Jacobi's integral is wholly unjustifiable. Under the secular action of a resisting medium such a capture is perfectly possible, and it has actually taken place, not only for the retrograde satellites, but for all of them.

5. The planets and satellites could have been formed in but one or more of the three following possible ways, and in no others whatsoever: (*a*) Detached from their central masses by acceleration of rotation, as imagined by Laplace. (*b*) Captured from the outer parts of a nebula devoid of hydrostatic pressure and thus added on from without, as announced by the writer in *A. N.,* 4308. (*c*) Formed right where they now revolve by the agglomeration of cosmical dust.

Now the possibility (*a*) is forever excluded by what I have called Babinet's criterion (*A. N.,* 4308); while (*c*) will not be seriously considered by any one of ordinary understanding. This leaves (*b*) as the only possible mode of formation.

6. Not content, however, with proving by the logical process of exclusion that the planets and satellites were captured, I have since developed a rigorous proof, based on a correct interpretation of Jacobi's integral under the physical conditions existing in actual nature, of just how the capture of satellites comes about. A series of papers on this subject is just now appearing in the *Astronomische Nachrichten,* No. 4341–42, 4343, etc.

7. It is thus proved that the planets were captured by the sun and have gradually neared that central mass under the secular action of a resisting medium. This cause and no other has given the orbits their round form. It is proved also that the satellites likewise were captured by their several planets. If Moulton and Chamberlin have reached any but negative results, I have not yet seen them, and I shall look forward with interest to their publication. Since naturally a thing has occurred in but one way, it is evident that there are in general an infinite number of ways in which *it did not occur.* Such negative results may be as numerous as the sands of the sea, or as the points in space; but they will no more nourish our minds than empty space will feed our bodies. I submit that protest against such vacant results is certainly justifiable.

T. J. J. See

U. S. Naval Observatory,
Mare Island, California,
August 2, 1909

"um" and "ium" endings

The Editor of Science: A subject which has interested me for some time is the existing lack of uniformity in the ending of the names of some chemical elements. In view of the fact that nomenclature is under discussion at the present time, possibly some remarks on the above subject may not seem presumptuous.

Some of my spare moments have been employed in trying to find if there were any conclusive reasons why five of the elements should have the endings they possess rather than endings in conformity with the majority of their brothers in the list of elements. The five I refer to are glucinum, lanthanum, molybdenum, platinum and tantalum.

Using Roscoe and Schorlemmer as authority, the number of "um" and "ium" elements is forty-seven. Five of these (the above mentioned) have "i" absent in the ending. Of the latter the Oxford English Dictionary and the Century Dictionary are authorities for spelling glucinum, lanthanum, tantalum both with and without the "i." Therefore there remain but two of the elements which as far as I have been able to discover are never spelled with the "ium" ending. In fact the leading text-books on chemistry and writers on scientific subjects spell all five elements with the "um" ending. So we are justified in believing it to be common usage to leave out the "i" in the spelling of the five elements under consideration.

Yet on the other hand there seems no really good reason (other than common practise, which is recognizedly potent) for discarding the "i." I have somewhat hurriedly scanned the works of Skeat, on etymology, in search of some authority, besides that of the elements' discoverers, for the prevailing spelling. I have been unsuccessful. Some time ago I was told by an eminent philologist that the formation of modern Latin words does not always follow fixed rules. Also, an eminent Boston chemist informed me that outside of the dictionaries he knew of no authority for the present spelling of the elements under discussion. It is evident that in the beginning the authoritative spelling of the name of any element is due to its discoverer in almost all cases. For when we read of the discovery of an element and learn that its discoverer gave it a name in conformity with the names of existing elements (provided it is an "ium" element) we observe that there is a tendency toward the species of uniformity which is the subject of this note.

If we take all the "ium" and "um" elements and consider them from the standpoint of—what I may call—syllabic uniformity, we see that there are twenty-six elements of three syllables; seventeen of four; three of five, and one of six. Platinum falls into the first class, and molybdenum into the second, which two classes compose the great majority. If we add "i" to the endings of these elements, then platinum still remains in the majority class and molybdenum passes into the minority. Can it be possible that the naming of the elements with a design for syllabic uniformity had a place in the minds of the various discoverers? It would seem fair to assume that such was not the case. Therefore a possible argument in favor of the present spelling of the two above mentioned elements is eliminated.

On the other hand, the argument in favor of what may be called terminal uniformity has more to recommend it than syllabic uniformity. Aside from the very desirable property of terminal uniformity itself, the sound of the pronounced word ending in "ium" is more pleasing to the ear, and its appearance is more pleasing to the eye, than is the word with the "um" ending, which gives the sensation of dullness, and is dumpy. While by simply adding "i" the pronunciation of the word "platinium" for instance, becomes at once musical. Any one uttering the word first with one ending and then with the other will appreciate the last remark.

In conclusion, one may say that although the "um" elements have back of them the power of common usage (as did aluminum some years ago—now we almost invariably write aluminium) yet there seems to exist an unnecessary lack of harmony in the spelling of some elements. However, this discord is not at all extensive, for according to the highest authorities the only elements at present irregular are platinum and molybdenum. It is only a few years ago that it was very common to write "aluminum," now it is rarely used by scientific writers. This change has been brought about by their adoption of the more approved spelling. Why may not the contemporary scientific writers go a step farther, and whenever they find it necessary to use the names of these elements, write them glucinium, lanthanium (lantanium), molybdenium, platinium and tantalium? Should the many influential scientific men find the suggestion here offered pleasing to them and furthermore worthy of adoption, then, in a short time, there would be introduced into the spelling of the names of elements a greater uniformity than at present exists.

G. B. O.

PROVIDENCE,
July 5

SCIENTIFIC BOOKS

Mendel's Principles of Heredity. By W. BATESON. 396 pp., 6 colored plates, 3 portraits of Mendel and 35 figures in the text. Cambridge (England) University Press; also New York, G. P. Putnam's Sons. 1909.

This is not a new edition of the book published under the same title in 1902 by the same author and publisher, but for some time now out of print. That little book served a useful purpose in directing the attention of

biologists to the newly rediscovered discoveries of Mendel, but at the present time a book with a wider scope is needed and it has been supplied by the author.

The present work omits the controversial features of its predecessor, which happily are no longer required, but adds in Part II. some interesting biographical material and three portraits to the translation of Mendel's original papers which the earlier book contained, and gives a comprehensive account of the development of Mendelian principles of heredity down to the present year. It may be regarded as an authoritative statement of Mendelism at the present time. No small part of the book is taken up with an account of the author's own investigations, which have probably added more to our present knowledge of heredity than has come from any other source since Mendel's time.

Chapter I. contains a brief account of pre-Mendelian writings on heredity, of the rediscovery of Mendel's law, and of the essential feature of that law, "segregation."

Chapter II. contains a list of observed cases of Mendelian inheritance, with the name of the observer in each case and bibliographic references to his work, and a statement of its most important features. The fact is emphasized that in animals and in plants, and both among domesticated and among wild forms, the laws of heredity are the same. The nature of "dominance" and the occurrence of distinctive heterozygous characters are topics also considered here. Regarding dominance, the conclusion is reached that "a dominant character is the condition due to the *presence* of a definite factor, while the corresponding recessive owes its condition to the *absence* of the same factor."

A critical comparison is instituted between the Mendelian system and Galton's system of analyzing the facts of inheritance, and the inadequacy of Galton's system is shown. Praise is bestowed upon Galton for his early attempts to break a path through the unexplored fields of heredity, but his followers are censured for persistently closing their eyes to the fact that Mendel has opened a path.

In a third chapter explanation is made of the usual Mendelian "ratios," 3:1, 9:3:3:1, etc., and an account is given of how novelties may arise, by recombination of the separate factors of compound characters. Examples from breeding-experiments with fowls, primroses and sweet-peas serve as illustrations.

The next five chapters, about a fourth part of the book, deal with color-inheritance in plants and animals. This is no undue amount of attention, since the phenomena here dealt with are the most carefully studied and the most instructive of all Mendelian cases.

In this part of the book are discussed and illustrated the modified Mendelian ratio 9:3:4, the "presence and absence hypothesis," epistatic and hypostatic factors, reversion on crossing, and a variety of related topics of greater or less complexity.

A chapter on "genetic coupling and spurious allelomorphism" precedes and leads naturally to a discussion of "heredity and sex." The theory is here advocated that sex has its ontogenetic origin in gametic differentiation, that in each species of animal or plant one sex is heterozygous, the other homozygous as regards the differential sex-factor. In the cases studied by experimental breeding methods the author concludes that "the female is a sex-heterozygote with femaleness dominant," whereas the male is a homozygous recessive. The possibility is, however, admitted that in insects, such as have been studied by Wilson, Morgan and others, the male may be the heterozygous sex, as the cytological evidence suggests.

Double flowers and their peculiar inheritance are considered in a special chapter, following which comes what to many will be the most interesting chapter in the book, "Evidence as to Mendelian inheritance in man." Eye-color and hair-color are shown to be inherited in typical Mendelian fashion, though the evidence is admittedly incomplete. Skin color, in the case of the mulatto at least, seems to be inherited without segregation. Various hereditary diseases and malformations are shown to be inherited as Mendelian dominant characters. Brachydactyly, cataract, color-blindness and a variety of other hereditary

peculiarities are here included. On the other hand albinism and alkaptonuria are recessive in heredity.

The next two chapters deal with exceptions, real or apparent, to Mendel's law, a most profitable field for students of heredity to cultivate; and the last two chapters of Part I. deal with the new light shed on biological conceptions by Mendelian discoveries and the practical application of Mendelian principles. The sociological application made, which will be of general interest, is stated concisely thus:

> To the naturalist it is evident that while elimination of the hopelessly unfit is a reasonable and prudent policy for society to adopt, any attempt to distinguish certain strains as superior, and to give special encouragement to them would probably fail to accomplish the object proposed, and must certainly be unsafe.

This is a conclusion both democratic and sensible, it would seem.

Part II. contains a biographical notice of Mendel, and a translation of Mendel's two published papers on hybridization, together with a very complete bibliography, an index of subjects and one of authors.

The book as a whole will be quite indispensable to the student of heredity; the general reader will find in it much of absorbing interest, although parts will be found too technical for him to follow readily, unless he too will become, as he will be tempted to become, a student of heredity.

W. E. CASTLE

Hints for Crystal Drawing. By MARGARET REEKS, with preface by Dr. JOHN W. EVANS, Imperial College of Science and Technology, London. Longmans, Green and Co. 1908.

The accurate construction of crystal figures usually offers considerable difficulty to the beginner and it was with a view of eliminating some of these difficulties as well as adding a few short-cut methods that this book of 148 pages with its 44 plates of drawings was published.

Of the various types of projections used by the mineralogist the one known as the clinographic projection is now usually employed and it is this projection which is chiefly considered. This is discussed in chapter I.

Chapters II. to IX., or fifty pages of the book, are devoted to directions for the drawing of crystals of the cubic system. The first three classes of this system are treated quite thoroughly and the plates illustrating a few of the common combinations aid the student in following the directions given. The tetragonal system is discussed in ten pages, the hexagonal in twenty, the orthorhombic in fourteen, and the monoclinic and triclinic in fourteen and nine, respectively, while the last eighteen pages are devoted to a consideration of twinned crystals.

In the construction of the axial crosses as well as in the drawing of the more complicated forms, the orthographic plan is first drawn and by dropping vertical projectors the corresponding points on the clinographic projection are located. This is a decided help to the beginner in pointing out the relationship existing between the two types of projections as well as for locating various points in the drawing itself.

But the text is not entirely free from criticism. The treatment throughout is from the standpoint of an experienced draftsman rather than from that of a skilled crystallographer. A few examples will make this point clear.

In the drawing of the tetragonal trisoctahedron $\{211\}$ (Fig. 1, p. 29) the intersection line P, 3 between the faces designated by II. and III. does not check with one found by the intersection of the two planes indicated. In Fig. 1, p. 35, the location of the point X can hardly be considered as accurate. The drawing of the tetragonal bisphenoid (Fig. 4, p. 65) is incorrect, for its edges should be parallel to lines joining the ends of the crystallographic axes. In the figure on page 79 the crystallographic axes are poorly drawn.

In all of the above-mentioned instances the general direction of the lines is correct, but carelessness in construction is clearly evident. This is to be regretted, for in a treatise on crystal drawing the figures should by all means be accurate. How can a student be

expected to construct correct crystal drawings if the text to which he naturally turns for comparison is lacking in this? If some of the figures had been drawn on a larger scale and then reduced these errors would have been to some extent eliminated.

Fig. 3, p. 51, is given as a combination of the plus and minus diploids. What the author has really drawn is a left gyroid (pentagonal icositetrahedron). Diploids are symmetrical to three principal planes of symmmetry whereas gyroids lack these elements. The figure of chrysolite on page 105 is very poor, as the lines of intersection of the bipyramid (111) with both the macro (101) and the brachy (021) domes are incorrect.

The method of determining the position of the axes of the triclinic system is an ingenious one, being a graphic solution of a spherical triangle when three sides are given. The last chapter on twinned crystals is very instructive, as the author gives numerous practical suggestions which are of great service in the construction of these difficult forms.

The work as a whole is a marked contribution to the science of crystal drawing and is a valuable reference book in spite of the errors referred to above.

Walter F. Hunt
Mineralogical Laboratory,
University of Michigan

The Chemical Constitution of the Proteins. R. H. Aders Plimmer, D.Sc., Assistant Professor of Physiological Chemistry in, and Fellow of University College, London. In two parts. Part I. London and New York, Longmans, Green and Co. 1908.

This volume forms one of a series of monographs appearing from time to time, covering selected topics in biological chemistry and written by investigators in the subjects dealt with. The contents are divided into the chemical composition of the protein molecule and the chemical constitution of its units, or the discovery and synthesis of the amino acids. The introduction gives a list of the proteins according to the British classification followed by a complete list, with their structural formulæ, of the various protein nuclei thus far discovered. The first section consists of a short survey of the methods employed for the decomposition of the proteins; this is succeeded by a detailed account of the method of isolation and estimation of the monamino and diamino acids, the former following the ester method of Fischer with some variations suggested by Levene and the latter employing the method described by Kossel. The results of the analyses of the various proteins made by the several authors are given in tabular form. The collection of this data and presentation in compact form forms one of the chief advantages of the book. The second section is but a compilation of data relating to the many protein nuclei covering the date of their discovery, determination of their constitution, and methods of preparations by synthesis. Some of these details have been tabulated at the end with the specific rotatory power of the natural and synthetic amino acids, mentioning by whom the observations were made. The book closes with a complete bibliography including about 500 titles and index.

The function of such a compilation must naturally be somewhat circumscribed. It can only be of value as a bibliography mainly and as a source of supply of somewhat complete data for the busy teacher who would utilize this book rather than investigate the original communications. The synthetic reactions are described by equations with structural formulæ which are undoubtedly a valuable aid to their proper understanding and elucidation. The contents are too detailed for the student; investigators and teachers would probably prefer to consult the original articles.

Practical Physiological Chemistry. A Book Designed for Use in Courses in Practical Physiological Chemistry in Schools of Medicine and of Science. By Phillip B. Hawk, M.S., Ph.D., Professor of Physiological Chemistry in the University of Illinois. Second edition, revised and enlarged. Philadelphia, P. Blakiston's Son & Co. 1909.

In the revision of the book the author has placed at the beginning a new chapter of

twenty pages discussing the enzymes, and the nomenclature of the proteins has been altered to correspond to the system adopted by the American Chemical Society. Otherwise the changes limit themselves to additions of new reactions in order to bring the book up to date. Although the book contains more material, the publishers have decreased the margins and thickness of the paper, so that the book appears smaller. It becomes somewhat difficult to indicate the exact purpose of this volume. At present it is in the transitional stage between a practical manual and a text-book. It is too bulky for a laboratory book; there is too much discussion of theoretical considerations, and many things are introduced which should not under any conception come into a laboratory course in physiological chemistry, *e. g.*, microscopical examination of urine for casts, etc., and counting of red and white blood cells.

Fortunate indeed would be the instructor of physiological chemistry in a medical school who could be allowed enough time in the curriculum to cover one half of the material between the covers. The book serves an excellent purpose as a reference book of test reactions, but in their multiplicity the student or the practitioner who wishes to become acquainted with a few of the most reliable tests would find himself bewildered and require additional advice in the matter. Were it not for its size and the necessity for such a decided picking and choosing of topics adapted for student laboratory work, the book would serve its purpose admirably. The contents are thoroughly reliable and the tests are given with sufficient detail so that the results should be satisfactory. The many figures and colored plates scattered throughout are excellent.

Upon the whole, the author is to be complimented and those interested in the subject congratulated upon the benefit derived by the publication of the revised edition.

H. C. JACKSON

ANTHROPOLOGICAL PUBLICATIONS OF THE UNIVERSITY OF CALIFORNIA IN 1908

THE University of California Publications in American Archeology and Ethnology have received during 1908 the addition of nine papers. These comprise volume 6, numbers 1, 2 and 3; the completion of the seventh volume, numbers 2 and 3; and volume 8, numbers 1, 2, 3 and 4. These papers embody the further results of the Ethnological and Archeological Survey of California which the university undertook a number of years ago, and which has since been pushed rather steadily towards completion. The weight of work published in the past year has fallen upon the ethnological side of the problem, rather than upon the archeology and linguistics of the state as in previous years.

In this definite field of ethnology a balance has been maintained in some degree between the northern, the southern and the central portions of the state. The two bulkiest papers of the period, Dr. Barrett's "Ethno-geography" and "Basketry" of the Pomo, treat of the peoples of the north-central region. These two are the most exhaustive treatments of their type that have appeared so far. The minuteness of the author's information concerning the region rests on long residence among the Pomo, in addition to extended scientific study. As a counterpoise to this work on the Pomo, four less laborious papers have been devoted to the "Mission" Indians of the extreme southern part of the state. Two of these latter are by Dr. Kroeber and the other two by authors from outside the university. As regards the central portion of the state, the rather varied territory occupied by the Miwok or Moquelumnan tribes offers the problem which is taken up in two of the three remaining papers.

An entirely different aspect of the ethnology of California is invaded by the final paper of the group, by Dr. William J. Sinclair. This paper enters with effect into the question of the geological relation of human remains and artifacts within the state of California. The range covered in the past season's publications is therefore seen to be rather wide. They perhaps contribute more manifoldly than is usual in a brief twelvemonth, to the general information concerning the state on its many sides as an ethnological field.

The Ethno-geography of the Pomo and Neighboring Indians, by S. A. Barrett. Vol. 6, Number 1.[1] Dr. Barrett's method in this, the largest of his three papers, includes the determination of certain dialectic areas in the Pomo territory, with sections of similar provinces among the Wintun, Yuki and Moquelumnan peoples. This is accomplished by means of vocabularies, together with comparison of the different phonetic systems. Of the seventeen areas isolated by Dr. Barrett in the paper, seven are Pomo, five Yuki, two Wintun and three Moquelumnan. A large map accompanying this treatise outlines the dialectic provinces established and makes clear their geographical relations to each other. In addition, the author has entered on his map 500 of the aboriginal village and camp sites of the Pomo, and some of the more important villages of the neighboring stocks. The work as a whole comprises, besides the maps, comparative vocabularies of 282 words in sixteen Pomo, Yuki, Wintun and Moquelumnan dialects, an extended introduction, discussion of phonetic and linguistic relationships, descriptions of village sites, and a full glossary of native words which enter into geographical names.

Pomo Indian Basketry. Vol. 7, Number 3. In this companion volume the author takes up with some minuteness the subject of the baskets and basket designs of the same people. The paper treats exhaustively of forms, technique, ornamentation and the native nomenclature of the designs. This people is particularly facile in handling decorative elements and surpassingly excellent in technique. Dr. Barrett's paper covers both aspects of his subject at length, in discussion as well as by photographic and diagrammatic illustrations. The work includes 231 text figures and 30 plates, together with a full glossary of native basketry terms. Like his former paper, it is more full and minute in outline than anything of similar nature which has been elsewhere attempted for California territory.

[1] Cite as: *Univ. of Calif. Publ. in Amer. Arch. and Ethn.*

Geography and Dialects of the Miwok. Vol. 6, Number 2. This paper is somewhat similar in outline to the "Ethno-geography," but is less comprehensive in scope. Like the former paper, it includes brief comparative vocabularies and a map indicating the results determined. Some of the vexed issues of the paper are taken up in a following number by Dr. Kroeber:

On the Evidence of the Occupation of Certain Regions by the Miwok Indians. Vol. 6, Number 3. The subject is an interesting one, in that the people concerned were in former times very important numerically, but were among the first to suffer at the advent of the whites. Since then the western units of the stock have so far disappeared that information is extremely scanty. This article, therefore, while necessarily brief, is most important and fills a place in the series which would otherwise tend to be much neglected from lack of proper material.

A Mission Record of the California Indians, by A. L. Kroeber. Vol. 8, Number 1. An entirely new departure is signalized by this paper from Dr. Kroeber. The material which he presents with editorial comments is drawn from authentic documents of the Mexican government written in Spanish, copies of which are in the possession of the Bancroft Library of the University of California. Material of such nature has double or triple interest in that it concerns the peoples who have been under the direct influence of the missions, and have therefore experienced violent modification of their original native customs and conditions. It antedates, moreover, in most instances, such systematized comments as are elsewhere extant concerning native American life. The original manuscript in the present instance is a "contestacion" or codified answer to a list of queries sent to the missions by the Mexican vice-regal government, and contains much that is in the first degree interesting and suggestive. The record as published includes only those parts of the original which are of direct ethnological interest. The significance of the study can be somewhat realized when it is learned that it embodies shorter

or longer statements concerning the conditions, in 1811, at sixteen of the missions. In this document is contained almost the only information at present available concerning the peoples originally around such places as San Luis Obispo, Monterey, Santa Cruz or San José. It is greatly to be desired that further sources in this field may be made accessible.

The Religion of the Luiseño Indians of Southern California, by Constance Goddard DuBois. Vol. 8, Number 3. The paper just mentioned affords an introduction to the recent studies of the Mission Indian region. Of special interest in connection with it is Miss DuBois's paper on the native religion of one part of the area. As in the case of Dr. Barrett's Pomo work, the problem which this author set herself was a definite one, and the fact that she spent some years in intimate association with the Mission peoples gave her an insight into many details. Many of the matters merely indicated or suggested by the Spanish document just touched upon are by Miss DuBois, fully discussed and described in intimate detail. Her paper covers the beliefs and ceremonies of the Luiseño, a Shoshonean people living about San Luis Rey, and includes some account of their mythology. She devotes 186 pages and four plates to the subject. The comparison of such recent and specialized research with the old Spanish commentaries, so far as they exist or may be brought to light, will always be particularly interesting and fruitful.

Ethnography of the Cahuilla Indians, by A. L. Kroeber. Vol. 8, Number 2. From another standpoint this ethnography of the Cahuilla, a second member of the so-called Mission Indian group, opens a no less stimulating field of inquiry. The Cahuilla are the least known of the three modern mission tribes. Dr. Kroeber outlines their geographical position, discusses their varied environment, and deals in detail with their material culture. His paper points to the necessity of including the Cahuilla with the "southern" cultural group of California. The text is accompanied by fifteen plates.

The Culture of the Luiseño Indians, by Philip Stedman Sparkman. Vol. 8, Number 4. Somewhat similar in general outline to the paper just mentioned is this treatise on the culture of the Luiseño. The author, who lost his life in the field, studied the people through a number of years, especially from the standpoint of their language. The present paper represents only a single aspect of his work among them. In it he takes up the most prominent facts of their culture and habitat, and discusses briefly their arts and crafts, their social institutions, and some of the more important features of their religion. At the close of the paper he catalogues the plants which were of importance to the primitive Luiseño, and designates their various uses. The paper is probably the least important of three excellent studies by the same author, all of which are shortly to be consigned to print.

Recent Investigations Bearing on the Question of the Occurrence of Neocene Man in the Auriferous Gravels of the Sierra Nevada, by William J. Sinclair. Vol. 7, Number 2. For upwards of forty years the vexed question of the appearance of man in Tertiary strata of California has called forth a great deal of testimony, pro and con. The question has centered to some degree around a small number of specimens, physical and cultural, found originally in the region of Tuolumne, Calaveras and El Dorado counties on the western slope of the Sierra Nevada. This testimony has been collated and reviewed by Mr. Sinclair in the present paper. The outcome of this latest study on the question quite possibly lays the whole matter at rest. Mr. Sinclair holds that in the face of all that has been said and written, no competent evidence of Tertiary man in California has ever to the present time been adduced. His work lies along both original and critical lines of study, and deals with first-hand evidence obtained by personal research on the ground.

In general interest, therefore, the papers of the twelvemonth just passed may be seen to cover a wide field, both geographically and in

range of subject matter. They indicate that the work now being done by the university is thoroughly specialized, and is organized on the broadest possible basis. The number of contributors is larger than in any previous year, and includes authors of a wide range of training and interest. In total bulk, the contributions of the period just passed (782 pages, 38 plates, 235 text figures and 3 maps) are larger than ever before in the history of anthropological work in California.

Thomas Waterman

BOTANICAL NOTES

ANOTHER KEY TO SACCARDO

A couple of years ago a brief notice was made in Science of a typewritten English key to Saccardo's "Sylloge Fungorum" prepared for the use of the mycological students in the University of Nebraska, and the statement was made that a few extra copies might be obtained on application. The results of the announcement were surprising. At once requests for the key came from all parts of the country, and within a week the small stock of the books was all sold out, and it became evident that a reissue or a new edition must be prepared. This has now been done by Professor Dr. Clements, of the University of Minnesota, and proof is now being read upon the new edition, which is to be printed and brought out as a small book. It will contain keys to "spore sections," to orders and families, and to the genera, besides some handy indexes, glossaries, etc. As it has been announced to be "ready by September 20" further notice may be deferred until the appearance of the completed work. In the meantime those who are especially interested in it may communicate with the author, as above, at Minneapolis.

A NEW COLORADO BOOK

Professor Ramaley, of the University of Colorado, has given us in his "Wild Flowers and Trees of Colorado" a charming little book intended to serve as an introduction to Colorado plants. In less than a hundred pages he leads the beginner far on the road to a knowledge of the vegetation of this state. He first discusses the general aspects of Colorado vegetation (ecology we often have called it in these later years) and then takes up the forests and forest trees of the state. He recognizes five zones or belts of vegetation, namely, the plains zone, foothill zone, montane zone, sub-alpine zone and alpine zone. These are admirably illustrated by many half-tone reproductions of well-selected photographs. The forest trees are briefly described by means of convenient keys, and the text is helped greatly by many illustrations. A bibliography including thirty-one titles completes this very useful book.

THE MINNESOTA BOTANICAL STUDIES

The resumption of publication of the widely-known "Minnesota Botanical Studies" is a matter of more than ordinary interest to botanists. The "Studies" were begun fifteen years ago by Professor MacMillan, under whom two fine volumes were completed, and parts 1, 2 and 3 of the third volume were issued, publication ceasing five years ago. Now under Professor Clements, part 1 of volume IV. makes its appearance with the same style of cover, paper and typography. In the present part, which covers 132 pages, there are six papers, viz: "Embryo-sac Development and Embryology of *Symplocarpus foetidus*," by C. O. Rosendahl; "The Seeds and Seedlings of *Caulophyllum thalictroides*," by F. K. Butters; "Influence of Physical Factors on Transpiration," by A. W. Sampson and L. M. Allen; "Two Basidiomycetes New to Minnesota" and "The Pezizales, Phacidiales and Tuberales of Minnesota," by D. S. Hone; "A New Genus of Blue-green Algae," by F. E. Clements and H. L. Shantz. The promise is made, also, that an index and title page "will be furnished at an early date" for the three preceding parts which are to constitute volume III.

RECENT SYSTEMATIC PAPERS

We may briefly notice the following contributions from the United States National Herbarium: Henry Pittier's "New or Note-

worthy Plants from Colombia and Central America" (XII., 5), with two plates and nine text figures; A. S. Hitchcock's "Grasses of Cuba" (XII., 6); J. N. Rose's "Studies of Mexican and Central American Plants—No. 6" (XII., 7); with eight plates and twenty-nine text figures; Paul C. Standley's "Allionaceae of the United States, with Notes on Mexican Species" (XII., 8) with sixteen plates and nineteen text figures; Britton and Rose's paper on "*Thompsonella*," "*Echeveria*" and "New Species of Crassulaceae" (XII., 9) with five plates; Britton and Rose's "Genus *Cereus* and its Allies in North America" (XII., 10), with sixteen plates; J. N. Rose's "Five New Species of Crassulaceae from Mexico" (XII., 10), with five plates; Coulter and Rose's "Supplement to the Monograph of the North American Umbelliferae" (XII., 10), with two plates; and G. N. Collins's "Apogamy in the Maize Plant" (XII., 10), with two plates showing the replacement of the staminate flowers by young leafy, and root-forming maize plants; and Wm. R. Maxon's "Studies of Tropical American Ferns—No. 2" (XIII., 1), with nine plates and one text figure, and including descriptions of many new species.

Much botanical activity is shown by the two recently issued "Contributions from the Gray Herbarium of Harvard University" (XXXVI. and XXXVII.), in the first of which there are papers by Alice Eastwood ("Synopsis of the Mexican and Central American Species of *Castilleja*" and "Some Undescribed Species of Mexican Phanerogams"); B. L. Robinson ("A Revision of the Genus *Rumfordia*," "Diagnoses and Transfers of Tropical American Phanerogams"); and H. H. Bartlett ("A Synopsis of the American Species of *Litsea*," "Notes on Mexican and Central American Alders," "The Purple-flowered Androcerae of Mexico and the Southern United States" and "Descriptions of Mexican Phanerogams"). It is worthy of notice that all descriptions and keys, whether generic or specific, are given in Latin, in accordance with Article 39 of the Vienna Code. The second contribution is John R. Johnston's "Flora of the Islands of Margarita and Coche, Venezuela," and consists of a general discussion of the vegetation, and controlling physical factors, an annotated catalogue of species, lists of the economic plants, distribution, and composition, etc. The paper, which covers about 150 pages, is accompanied by two maps of the islands, and six plates illustrating the vegetation or structural details of the plants.

E. L. Greene resumes the printing of his "Leaflets" (Vol. II., 1–24, February, 1909) by the publication of four papers—"New Species of the Genus *Mimulus*," "New Western Asteraceae," "New Composites from Oregon, Washington and Idaho" and "New Plants from Arizona."

Here may be noticed Rosendahl and Butters's "Guide to the Ferns and Fern Allies of Minnesota" intended to enable students to identify the sixty species of these plants found in the state. This is accomplished by means of keys, plates and text figures, all of which are excellent.

"The Forests of Mindoro," by M. L. Merritt, of the Philippine Bureau of Forestry, is a fifty-page pamphlet of much interest to both foresters and botanists. It is intended to give some idea of the country, the distribution and the composition of the forest areas of the island of Mindoro. This island lies about a hundred miles southwest of Manila, and contains a little less than four thousand square miles. A mountain chain extends its whole length, rising at one point to 8,500 feet, and this is bordered with foothills and broad alluvial coastal plains. Nearly two thirds of this area is covered with forests, the remainder is nearly all uncultivated grass lands, only about one per cent. being under cultivation. The report, which is illustrated by ten half-tone plates, and a map, closes with a "list of tree species collected in Mindoro and smaller adjacent islands," numbering 560 species. When we remember that these occur upon an area equal to about half a dozen counties the richness of the forest flora may be appreciated.

C. B. Robinson's "Philippine Chloranthaceae" and "Philippine Phyllanthinae" (*Phil. Jour. Science*, April, 1909) includes a sys-

tematic treatment of the genera and species of these two groups, the first with but two genera and three species, the second with seven genera and fifty-four species.

Here should be noticed the recent "Heften" (3, 4, 5, seventh series) of Karsten and Schenck's "Vegetationsbilder." The first of these by Otto Feucht illustrates the Black Forest; the second, by L. Adamovic, deals with Dalmatian vegetation, and the third, by Felix Rosen, illustrates the characteristic plants of the Abyssinian highlands. The plates maintain the extraordinarily high degree of perfection which has characterized the previous numbers, and the text is all that could be desired. How the German publisher (Fischer) can afford to publish these Heften for the low price of four Marks each is a source of wonder to American botanists.

RECENT PAPERS ON ALGAE

Professor Griggs's paper "Juvenile Kelps and the Recapitulation Theory" (*Am. Nat.*, January and February, 1909) takes up a profitable line of inquiry as to the young stages of many of the large brown sea-weeds, giving especial attention to *Renfrewia, Lessoniopsis, Egregia* and *Hedophyllum*. He reaches the conclusion, contrary to that of many zoologists, "that though organisms are subject to adaptation at any stage of their life cycles and may gradually cut out superfluous stages, yet, except as some such tendency has operated to change the heritage, the development of the individual does recapitulate the history of the race."

Dr. M. A. Howe's "Phycological Studies—IV." (*Bull. Torr. Bot. Club*, February, 1909) is devoted to a monograph of *Neomeris* (of which there are now known six species); two West Indian species of *Acetabulum;* a new species of *Halimeda* (from the Bahama Islands), and several species of *Udotea*, accompanied with six helpful plates.

Wittrockiella is the very pretty generic name given by the well-known Norwegian algologist, Wille (*Nyt Mag. of Nature*, Cd. 47), to a small, fresh-water chlorophyll-green alga which occurs in the brackish waters of southern Norway in company with *Rivularia, Microcoleus* and other *Myxophyceae*. It is related to *Trentopholia*, and has been made the type of a new family, *Wittrockiellaceae*, of the order *Chaetophorales*.

Other papers on algae are Otto Müller's "Ortsbewegung der Bacillariaceen," VI. and VII.; A. Scherffel's "Asterococcus," and "Schizochlamys" and N. Wille's "Oocystis," in recent numbers of the *Berichte d. Deutschen, Bot. Gesellschaft.*

A HANDFUL OF FUNGUS AND PATHOLOGICAL PAPERS

One of the best-printed bulletins on fungi that has come to notice is Dr. N. A. Cobb's "Fungus Maladies of the Sugar Cane," issued by the Experiment Station of the Hawaiian Sugar Planters Association (Bull. No. 6, of Division of Pathology and Physiology). The paper, printing and illustrations are remarkably fine. The text will prove interesting to most botanists, especially those who have not followed strictly the latest developments in plant pathology. Thus the stinkhorns (Phallaceae) are shown to be associated with a root disease of the sugar cane, and species of *Ithyphallus, Dictyophora* and *Clathrus* are described as pretty certainly responsible for the injury. Other diseases of the cane, as "tip wither," "ring spot," "eye spot," "rind disease," etc., are described and remedies suggested. With this portion of the text there are seven elegant colored plates. The closing chapter is devoted to "timber rots," and here the text illustrations are unusually fine.

From the Bureau of Plant Industry of the United States Department of Agriculture we have a bulletin on "The Control of Black-rot of the Grape," by Messrs. Shear, Miles and Hawkins, in which the conclusion is reached that proper spraying with Bordeaux mixture is effective in preventing the disease. Other papers from the bureau are J. R. Johnston's Bud-rot of the Coconut Palm" (thought to be due to bacteria); Perley Spaulding's "European Currant Rust on the White Pine in America" (a recent importation); the same author's "Present Status of the White Pine Blights" (a very useful summary of what is known of this "complex of several different

diseases"); and Metcalf and Collins's "Present Status of the Chestnut Bark Disease" (due to *Diaporthe parasitica,* which thus far has baffled all attempts at control, by anything less than the destruction of the diseased trees).

In Dr. Clinton's "Report of the Station Botanist" (Conn. Agricul. Expt. Station, 1908) he takes a more hopeful view of the future of the chestnut bark disease, believing that the trouble is largely due to "winter injury" rather than to the fungus above named, and that it "is now probably about at the height of its development, so that not much additional harm may be expected." Another paper in the same report takes up another puzzling disease, peach yellows—and here, also, a suggestion is made as to its nature which at least has the merit of some probability. The closing paper gives the results of artificial cultures of *Phytophthora* of different species. This will be most useful to mycologists who may wish to introduce this method of study in their laboratories.

Other papers which may be mentioned here are Professor DeLoach's "Studies on the *Colletotrichum gossypii*" (Bull. 85, Georgia Expt. Station); W. T. Horne's "Report of the Department of Vegetable Pathology" in the report of the Estacion Central Agronomica of Cuba (1905–09), and an earlier one by the same author devoted to coconut diseases (Bull. 15); Freeman and Johnson's "Loose Smuts of Barley and Wheat" (Bull. 152, Bureau of Plant Industry); C. W. Edgerton's "Perfect Stage of the Cotton Anthracnose" (*Mycologia,* May, 1909); the same author's "Anthracnose or Pod Spot of Beans" (Bull. 116, La. Expt. Sta.); J. G. Grossenbacher's "Mycosphaerella Wilt of Melons" (Tech. Bull. 9, N. Y. Expt. Sta.); and G. W. Wilson's "Notes on Peronosporales for 1907" (Bull. Upper Iowa University, XI., 3).

We have space for only brief mention of the following, also: Century XXIX. of "Fungi Columbiani" (Elam Bartholomew, Stockton, Kans.) devoted wholly to fungi collected in Arkansas; Fawcett's "Fungi Parasitic upon Aleyrodes citri" (Special Studies, 1; Univ. Florida), with six plates; Rorer's "Bacterial Disease of the Peach" (*Mycologia,* January, 1909); Edwards and Barlow's "Legume Bacteria" (Bull. 169, Ontario Agricul. Coll.).

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SPECIAL ARTICLES

THE CONSERVATION OF MASS AND THE PASSING OF MATTER

TO THE EDITOR OF SCIENCE: The article by Professor Lewis in the *Technology Quarterly,* discussed in your issue of April 23, 1909, by Professor Speyers, is one answer to the obvious necessity for an enlargement and restatement of some of the fundamental concepts of physics.

The discovery of radioactivity by M. Henri Becquerel, and that of polonium by Mme. Curie, initiating us into the knowledge of a new order of phenomena, together with the observation by P. Curie and Laborde of a continual production of heat by radium, and the splendid experiment of Kaufmann on the variation of mass with velocity, finally the suggestion by Rutherford and Soddy that the atoms of the radio-elements disintegrate with production of helium, confirmed in the face of great difficulties by Sir William Ramsay and Mr. Soddy, have placed before us an array of new facts for which new doctrines are imperatively needed.

We may recall that the investigations of Larmor, J. J. Thomson, Hicks and others, exhibit to us a conception of an atom as a world in miniature, where internal revolutions and reactions of distinct internal entities at enormous speeds give a basis for the discussion of latent energies implied by the physical fact of the inertia of the atom.

That the mass of a body is nothing but the energy of its ethereal rotation is a view which I have held tentatively. Following the equations used by Professor Lewis, and introducing this further premise, let $M =$ momentum, $M' = Mr =$ angular momentum, or "moment of momentum," of the ether, where r is the radius of gyration of the reciprocating rotations of the ether. The complex of these integrated rotations constitutes an electromagnetic wave whose amplitude diminishes with r as the spherical wave-front expands. Let

P = normal radiation-pressure corresponding to the radiant energy per unit of volume of the ether = ethereal moment of momentum transferred per unit of time to a normal surface; m = the mass of a body, an atom for example, E, its energy, either actual or potential, v, its velocity; V = velocity of light; and t = time. Then according to the Maxwell-Bartoli formula,

$$P = \frac{(1+\rho)}{V} \times \frac{dE}{dt}$$

where ρ is the reflecting power of the surface which receives the radiation. Under the action of this radiant pressure, there is a transference of energy from the ether to matter which may be regarded as the transferring of a definite amount of angular momentum from the ether to matter, according to the equation

$$M'/t = dE = dm \times V^2. \qquad (1)$$

Whether the energy received by an absorbent particle from radiation shall be manifested in the body as kinetic energy of mechanical motion, or as thermal energy, is a detail depending on whether the particle is free to move, or is constrained by its linkage to other particles.

We may distinguish between the free ether and the ether which is bound in material vortical motion; but in a slightly different sense the ether can never be said to be free, for it is everywhere in contact with itself. The angular momentum of a free material body is invariable. It can not be altered from within, and can only be transferred by contact. But the angular momentum of the ether which is everywhere in contact is always transferred. Mass, as a property of ether, is purely temporary. The ethereal mass is strictly proportional to the radiant energy and disappears with it. Equation (1) which expresses a relation between ether and matter, may, however, be applied to the ether alone, if m and E denote its transient mass and energy during radiant activity.

The earth, by virtue of its orbital motion, possesses a great store of potential energy for the production of heat. An atom, by virtue of the internal motions of its electrons, possesses a relatively enormous potential energy. Neither of these stores of energy can be converted into heat except by some sort of collision which disturbs and disarranges the harmonious motion. The distinction between actual and potential energy depends upon the point of view. The kinetic energy of terrestrial orbital motion is actual mechanical energy, but in relation to thermal energy the kinetic energy is potential. Upon this energy of a planet's orbital revolution there are superimposed the kinetic energy of its axial rotation, that of the motion of the entire solar system along the sun's way, relatively to the gravitational center of motion in the galactic agglomeration of which our sun forms a part, and the unknown motion of the galaxy as a whole, relatively to some point in absolute space. The total energy of a body is an unknown quantity, save as it becomes theoretically possible to predict it in the way that Professor Lewis has pointed out.

Recognizing that only a small part of the total energy-content of a body comes within our cognizance, and that comparatively only a brief interval in its history can come under observation, I think that we may, with all humility in acknowledgment of our limitations, nevertheless find in the relations between light and matter an epitome of the history of the physical universe. If mass can be transferred through light, it follows that mass may be said to *originate* from light, that is, from ethereal rotation so circumstanced that the motion becomes circumscribed and the energy prevented from dissipation by ordinary agencies.

The mechanical action of light observed by Crookes, although not certainly separated by him from mechanical action due to the residual gas of his vacuum tubes, has now been completely demonstrated by Lebedew, and by Nichols and Hull, and has been shown by the latter to be independent of the wave-length, and in agreement with the prediction from electromagnetic theory.

Although the rapid motion of finely divided matter in comets' tails may be explained on the hypothesis of electric repulsion, the demand for a large solar electric field has been

considered a difficulty, and astronomers have welcomed the suggestion that this motion and that of similar material in the solar corona may be due to light-pressure. The acceleration produced by solar gravity at the earth's distance being

$$\frac{0.593}{982.15} = \frac{1}{1656}$$

of the acceleration by terrestrial gravity at the surface of a spherical earth, the light-pressure from solar radiation at this distance on a body of small size whose receiving surface is very large compared with its volume and mass, may exert an accelerative action several times that due to solar gravity, the differential acceleration giving an accumulating velocity away from the sun.

Professor Edwin B. Frost and Mr. J. A. Parkhurst find from their spectroscopic observations of Comet Morehouse that "particles of the same [chemical] constitution are thrown out from the head at angles at least 40° asunder."[1] Bredichin's hypothesis in explanation of cometary tails of various types requires in this case that the particles forming individual component streamers of the tail shall be of different sizes, rather than of different sorts, since the several chemical compounds are not distributed unequally, but are everywhere indiscriminately mingled. No change of composition whatever occurs through a stretch of several degrees of the comet's tail, so far as can be inferred from the spectroscopic evidence.

If the masses of the particles have been changed, it may be asked, will there not be a change in the spectrum? Perhaps not in this case. The change of mass corresponding to the velocity observed in the particles of a comet's tail will be very small, according to the results of Kaufmann's experiment, and need not necessarily produce any sensible change in the spectrum; but at high velocities approaching that of light, such changes would be anticipated, and we have evidence that such changes do occur. It has long been known that vacuum tubes filled with various gases most carefully prepared for exhibition of their several spectra, suffer gradual change, the spectra being eventually reduced to other and simpler ones until at last possibly nothing but hydrogen remains. Attempts to explain this behavior on the supposition of the presence of impurities, or by the occlusion of gases in the walls of the tube, and the gradual absorption or emanation of such residual gases, have been only partially successful. The true explanation which finally emerges is that the atoms of large atomic weight are eventually broken down as a result perhaps of repeated collisions at high speed under electric repulsion, and are resolved into simpler atoms. Sir J. J. Thomson finds that the positive rays in high vacua, where great velocities have been electrically produced, consist of particles of not more than three sorts which are probably hydrogen, the alpha particle, and helium, and that this is so *no matter what gas is put into the tube.* It is notable that the luminous emanation from *Nova Persei* appeared likewise to consist of particles of *three* sorts, and having masses *in the same ratio* (1:2:4) as those observed in the vacuum tube. I think, therefore, there can be no doubt that the nebulosity around *Nova Persei* was an example on an enormous scale of Goldstein's "canal rays."

The recent observations of Comet Morehouse are not clearly decisive for or against the theory of light-pressure. Barnard finds that the motion of luminous knots along the tail is unaccelerated. The development of a comet's tail takes place at the rate of something like 100 km. per second, and is maintained unaltered through distances comparable to that separating the sun from the earth. This result was obtained in a vague way many years ago by Olbers and others, but from observations which rested on the very uncertain limit of the visibility of the extremity of a comet's tail. Barnard's observation is more precise, and is in agreement with the hypothesis of a force whose acceleration diminishes as a result of the motion imparted by its own action.

Next in importance to the observed velocity must be placed any information which can be obtained as to the size of the particles. The

[1] *Astrophysical Journal*, 29, 63, January, 1909.

spectroscopic measures of Comet Morehouse at the Yerkes and Lick Observatories show that the light from the tail proceeds almost entirely from gaseous molecules. But Schwarzschild has shown that there can be very little light-pressure on free gaseous molecules, because their dimensions are so small that they diffract the light and remain themselves comparatively unaffected. If the motion is due to pressure of light, it would seem to follow that the gaseous spectrum of the comet's tail must be that of small separate atmospheres enveloping and attending moving particles which are not otherwise visible, but are the objects directly impelled by the luminous impact. A gradual diminution of size of the particles by electric dissipation or by evaporation would give a diminishing efficacy to the repulsion, but whether this would be compatible with the observed motion can not be determined.

The cometary evidence being indecisive, the argument for the interaction of ether and matter must rest for the present on the observed mechanical pressure of light, and on Kaufmann's experiment, with the addition of such inferences as are suggested by the phenomena of radioactivity and the behavior of matter in highly exhausted vacuum-tubes.

The variety of new properties of matter observed with a high vacuum is sufficiently extraordinary. The interior of a vacuum tube is virtually a new world, where the physical laws with which we are familiar are in appearance frequently contravened. According to the ordinary laws of gases, any gas set free in a vacuum-chamber might be expected to diffuse almost instantly to every part of the exhausted volume. Nevertheless, in heating the gas-regulator of an X-ray tube to restore a minute amount of gas to a tube of too high resistance, the gaseous matter may be seen trickling along the walls of the tube in a network of apparently viscous filaments, the gas behaving as if it were a viscid liquid, adhering to the walls of the tube and reluctant to leave them.

In my paper "An Inquiry into the Cause of the Nebulosity around Nova Persei"[2] I have shown that particles analogous to those of cathode rays were shot off from the star with velocities in some cases scarcely inferior to that of light; and yet, at distances from the center of dispersal which are comparable with those from star to star, the motion bore witness to a control which was not gravitational, but resembled rather a magnetic control emanating from the star. The mere suggestion that a magnetic field can exist at stellar distances capable of guiding particles, of any kind whatsoever, will evoke the exclamation "impossible!" But having learned from the behavior of vacuum-tubes that many very strange phenomena are of every-day occurrence in these novel realms of vacuous space, it may be well to enlarge the bounds of preconceptions.

Professor Speyers's equation (7) does not fit the facts, but his equation (8), which agrees with that given by Professor Lewis, conforms to the data of observation. The source of the discrepancy comes from a failure to distinguish between the mass of the ether and that of the body receiving radiation. If, for clearness, we call the former m' and the latter m,

$$dE = V^2 m' = V^2 dm,$$

and

$$V dm = mv = M$$

(if the velocity of the body receiving the radiation is wholly due to light-pressure, M being the temporary momentum of the ether), whence, since $m = m_0 + dm$,

$$dm/m_0 = v/(V - v).$$

This equation may be substituted for equation (7).[3] It gives for the mass of a particle moving at any velocity up to that of light,

$$m_0 + \frac{dm}{m_0} = m_0 + \frac{v}{V - v} = m_1,$$

or

$$m_1 - m_0 = v/(V - v)$$

and

$$m_1 - m_0 = \infty,$$

if $v = V$, as the theory of Kaufmann's experiment requires.

In saying that "the mass of the body struck

[2] *American Journal of Science*, July, 1903.

[3] *Loc. cit.*

[by radiation] increases as it moves [faster] . . . but only as it receives *this particular form of energy*,"[4] Professor Speyers is, it seems to me, endeavoring to express a distinction which must be recognized, but in terms which can not be admitted if non-Newtonian mechanics is accepted. The mass of the ether is only temporary; it does not become infinite though moving with the velocity of light, and it can be transferred. There are not, however, two kinds of energy—one the energy of mechanical motion, the other, radiant energy. There is only one energy in the physical universe, but two sorts of mass—temporary for ether, permanent for matter, both of them being energy of ethereal rotation. I am entirely in agreement with Professor Lewis that the substance (meaning by this word no ordinary matter everywhere and at all times amenable to gravitation, nor yet a purely metaphysical substance, but a universal interstellar medium which has physical properties different from ordinary matter) "which in a beam of light has mass, momentum and energy, and is traveling with the velocity of light, would have no energy, momentum or mass if it were at rest"; but "if it were moving with a velocity even by the smallest fraction less than that of light," it would cease to be free ether, and would have quite different properties. Now this is just what might be expected if matter is formed from the ether, for however it may be formed, matter must be differentiated from the ether by a *per saltum* change, ordinarily irreversible. Whether we consider the condensation of a large volume of ether containing a powerful luminous energy into the dimensions of a corpuscle still retaining the electro-magnetic energy of the original volume, or regard the birth of an elementary particle as in the nature of a cataclysm which opens a rift in a medium of great strength and density, in other words, whether we conceive the ultimate particles of matter to be vacuities in an exceedingly dense ether, kept from collapsing by the centrifugal pressure of a rapidly rotating shell, or as condensations in an elsewhere excessively rarefied medium, in either case the circumscribing of a definite volume with properties other than those of the general medium presupposes a surface of discontinuity of some sort around the segregated portion, such as might be produced by a sudden change in the ethereal velocity at this singular surface. It may be a question whether the permanent mass (m_0) of a material body is exactly equal to its ethereal angular momentum divided by the velocity of light

$$m_0 = M'/V.$$

The circumscribing of the ethereal motion may be attended by some departure from the universal velocity in the free ether, but this is simply to say that the materialized ether is distinct from the free ether.

In an article in *Nature*[5] Professor Larmor, in commenting on the fact that the Doppler effect requires "some kind of thermodynamic compensation, which might arise from ethereal friction, or from work required to produce the motion of the body against pressure excited by the surrounding radiation," says: "The hypothesis of friction is now out of court in ultimate molecular physics," but it comes into court again with the discovery that atoms are destroyed and that new radiant energy is thereby imparted to the ether. If radiation, in turn, generates mass, as I have suggested in my paper, "A Cosmic Cycle,"[6] or in the less problematical way which Professor Lewis has now virtually demonstrated, it is difficult to conceive how this can be done without some sort of ethereal reluctance analogous to viscosity in a gas; and granting such a reluctance, we might anticipate some retardation of the normal ethereal velocity in the transformation.

In the paper cited, I have defined energy as "the modification of ethereal rotation, or the establishment of rotation at new points in the ether." Radiant energy is electromagnetic rotation of the ether, differing in no wise essentially from the ethereal rotations within an atom whose energy makes the atomic mass,

[4] *Loc. cit.*, p. 657.

[5] Vol. 63, p. 216, December 27, 1900.

[6] *American Journal of Science*, 13, 193, March, 1902.

save that the latter is very nearly permanent. Not a special velocity *per se*, but the being, or ceasing to be, of a special ethereal rotation is what apparently conditions the phenomenon.

As Mons. Hirn says in his attempt to define energy:[7]

> What we call kinetic energy or mechanical work consists of quantities which are not necessarily bound to the existence of ponderable matter.

To borrow an illustration from Hirn, we may compare the following two ways of heating a bullet. When a projectile, such as a ball of lead, strikes a rigid obstacle, it becomes hot, and the quantity of heat developed (and divided between projectile and obstacle) is rigorously proportional to the external kinetic energy which has vanished for the time being. But we can heat the leaden ball just as well by exposing it to the sun's rays; and here again the temperature, or elevation of thermal activity, is related to the radiant movement extinguished. The kinetic energy of the radiation, which was that of an original radiant beam or column of ether, has been destroyed as radiant energy, but not as essential energy. The energy has simply been transferred; but there is a distinction between the two modes of heating the bullet. The radiant energy extinguished is *completely* transferred to the absorbent. The thermal energy developed by impact is divided between missile and obstacle. This distinction is fundamental, and prevents the identical application of a law expressing the relation between ethereal and material energy, to the interchange of energy between different portions of matter. Kaufmann's experiment belongs to the first category. The distinction, which has no counterpart in the transference of momentum by sound waves or water waves, has its place in the system proposed by Professor Lewis. The kinetic energy of a mass which moves with the velocity of light is mV^2, but that of a mass moving with the ordinary velocities with which we have to deal in Newtonian mechanics is $\frac{1}{2}mv^2$. That the distinction is not an absolute one, but that for velocities somewhat slower than that of light, the mathematical expression for kinetic energy passes through intermediate values, is a view which reconciles these diverse modes of subdivision of energy.

I venture to suggest that Mr. Speyers's difficulty in regard to the lesser velocity of light in water is not a real one; because owing to innumerable, minute, alternating deflections of the light ray in passing through the bound ether attached to the molecules, the path of the light is lengthened. There is no necessary change in the true ethereal velocity.

Ordinarily, the mass of a body of matter can not be transferred; but in radioactivity, and in atomic disintegration and destruction produced in any way, energy returns into the ether, and may be transferred as temporary ethereal mass, just as in the case of radiant energy, of which it is perhaps a special form. The ordinary destruction of atoms is excessively slow, nevertheless every flame involves *some* minute amount of atomic destruction.

The laws of the conservation of mass and of energy require restatement. Taking the universe as a whole, there is always a restoration of mass or of energy which disappears in time at some given point, but in general reappears at some other time or place. Thus if atoms are destroyed in radioactive transformations, there must be some other part of the universe where these atoms are reproduced. Temporarily the energy concerned in the formation of an atom is set free in the destruction of the atoms of radium, evolving enormous quantities of heat. Some of this heat may be immediately transformed and all will be eventually transformed into radiant energy, passing out into the free ether, there to exist for a time as temporary mass until it is again fixed in new forms of *material* substance, for the ether is the great storehouse of energy. Shall an atom outlast a star? Are they not both parts of a fleeting imagery—a series of dissolving views which come and go as the ages move?

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May 3, 1909

[7] "La notion de force dans la science moderne," p. 47.